JUN 10 1940

ENGINEERING NEWS-RECORD

Installing steel roof supports in one of the Pennsylvania Turnpike tunnels.—*see p. 778*

JUNE 6
1940

TUNNELING ON THE TURNPIKE

You Can Write the Order

THAT WILL END SEWER TROUBLES!

Here's a way to solve those difficult sewer problems once and for all. Specify Asbestos-Bonded ARMCO Sewer Pipe for economical repair work or new construction.

Asbestos-Bonded ARMCO Pipe meets every sewer line requirement. Its flexible corrugated design eliminates breakage and strong, tight joints greatly reduce the danger of infiltration. Long lengths mean fewer joints per mile and lower installation costs. Cradling is unnecessary.

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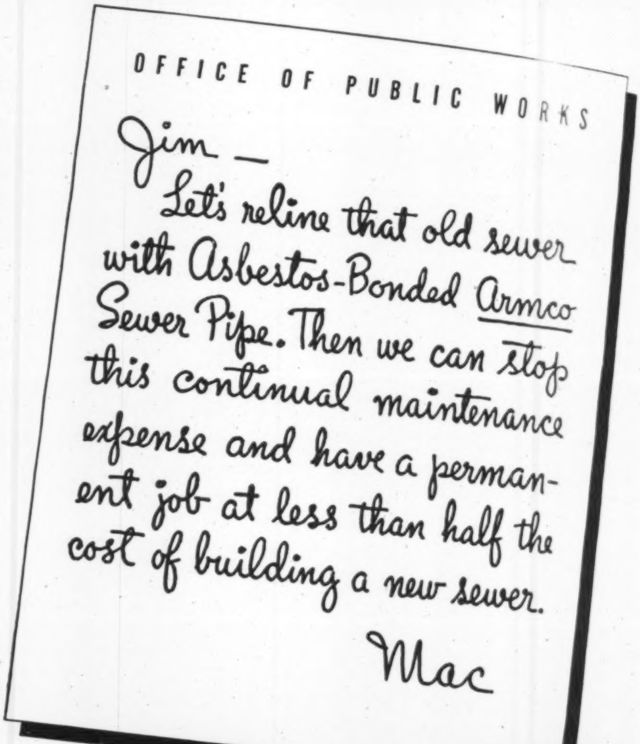
Many major cities have benefited by installing Asbestos-Bonded ARMCO Sewer Pipe. Yours can too. A request to us will bring you complete information with no obligation. Armco Drainage Products Association, 5010 Curtis St., Middletown, Ohio.



OFFICE OF PUBLIC WORKS

Jim —
Let's reline that old sewer with Asbestos-Bonded Armco Sewer Pipe. Then we can stop this continual maintenance expense and have a permanent job at less than half the cost of building a new sewer.

Mac

A disintegrating brick sewer is permanently repaired with Asbestos-Bonded ARMCO Sewer Pipe. Approximately 600 feet of 72-inch ARMCO Pipe was threaded into the sewer without interrupting street traffic and at less than half the cost of rebuilding.

ASBESTOS-BONDED ARMCO ARMCO SEWER PIPE

ORIGINATED AND DEVELOPED BY ARMCO ENGINEERS

ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigation, Canals, Railroads

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THIS WEEK

- An important defense message to all industrial America is contained in a special insert at the end of the editorial section of this issue. An analysis of the industrial mobilization problem, it is also an announcement by the president of McGraw-Hill that the editorial resources of all of the company's publications are being marshalled to render the widest possible aid to industry in its defense job.

- Bottlenecks in the high-speed construction program for the Pennsylvania Turnpike have been its tunnels. How six contractors have shoved an amazing footage of two-lane tubes through all kinds of rock and earth is told on p. 48.

- Long water supply lines at different ends of the country are discussed from widely different viewpoints in two articles. One is a record of 25 years maintenance experience on the Los Angeles Aqueduct and the other is number four in *News-Record's* series on New York's Delaware Aqueduct.

- Flood control, irrigation and power production are the three purposes of the system of dams under the direction of the Lower Colorado River Authority. Clarence McDonough, general manager of the authority, tells the system's story.

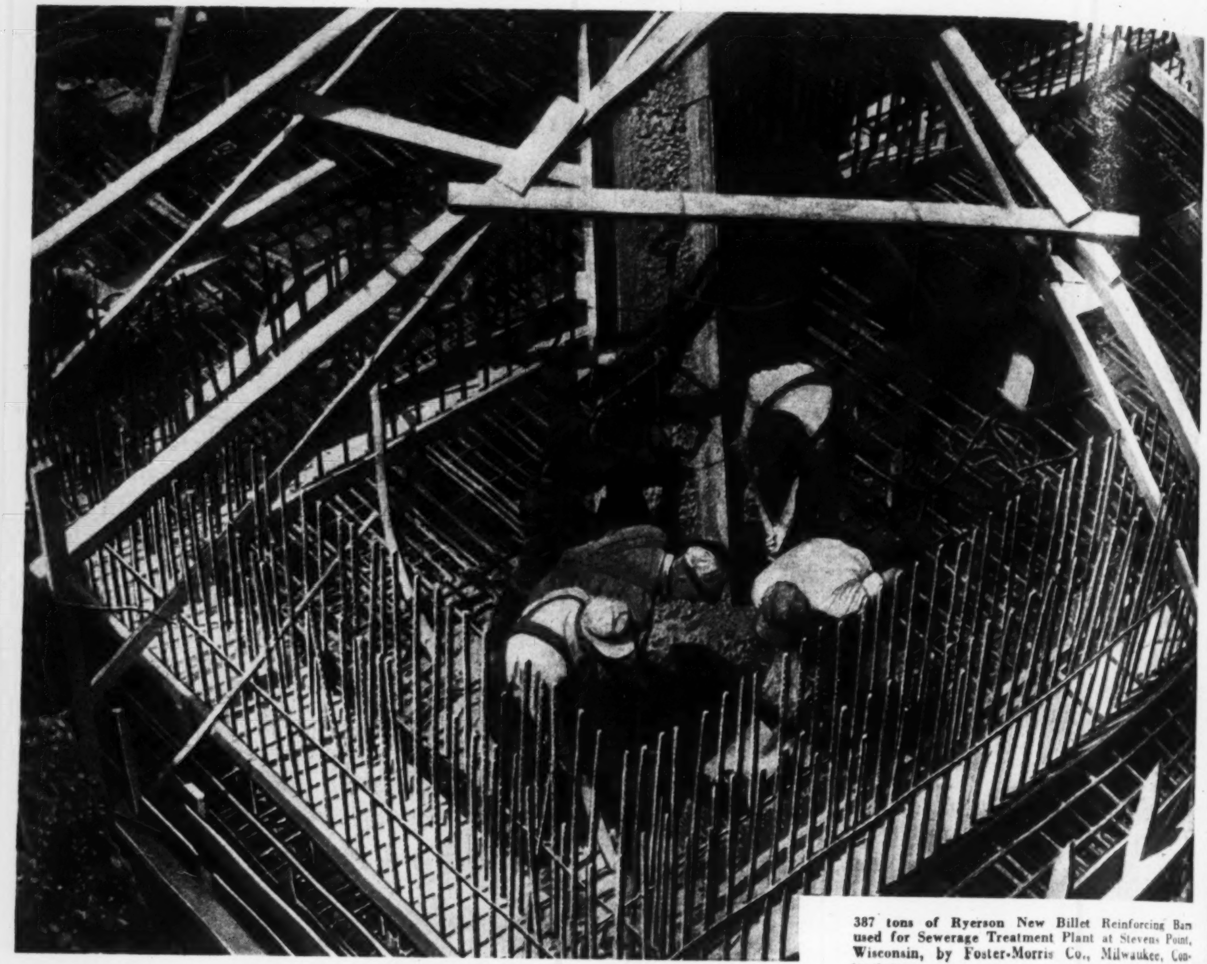
THINGS TO COME

June 20

Annual Construction Cost Book

ENR's 2-in-1 issue

IN COMBINATION with the regular editorial content, the June 20 *News-Record* will include a voluminous section on construction costs. This cost yearbook of the construction industry will go to 35,000 readers free, and if past performances are any criterion hundreds more will order copies of the issue at $2.00 each.



387 tons of Ryerson New Billet Reinforcing Bars **used for Sewerage Treatment Plant** at Stevens Point, **Wisconsin, by Foster-Morris** Co., Milwaukee, Contractors.

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NEWS
ENGINEERING NEWS-RECORD

Volume 124 JUNE 6, 1940 Number 23

Aircraft Manufacturers Plan Big Additions

Boeing Aircraft Co. last month awarded a contract to the Austin Co., Cleveland, for construction of a $2,000,000 addition to its No. 2 assembly plant at Seattle, consisting of an 826x227-ft. warehouse and a 550x150-ft. addition to the plant proper. Both structures will be 54 ft. high and will contain 600,000 sq.ft. of floor area.

The assembly plant, when the Austin contract is completed, will be 1,000 ft. by 450 ft. in size, one of the largest in the Pacific Northwest.

Pratt & Whitney Aircraft Division of the United Aircraft Corp. has also announced plans to spend $8,000,000 for expansion of plant and equipment at East Hartford, Conn. The expansion is among the first moves to meet the plans of the national defense program, which places emphasis on aircraft production.

• • •

Construction Curtailed In Canadian Budget

Annual budget estimates for the Dominion of Canada, introduced to parliament late last month, include but $15,000,000 for expenditure this year by the Federal Department of Public Works as against $32,000,000 last year. It has been announced that although existing contracts will be completed, no new public works will be undertaken by the government other than those required for war work.

• • •

Bids Asked for High Dam At Marshall Ford

Bids are asked June 14 for construction of the addition to Marshall Ford Dam to bring the dam to its full planned height of about 235 ft. above the river bed.

Principal construction items involved are 460,000 cu. yd. of mass concrete and more than 1,500,000 cu. yd. of all types of excavation.

Money For Navigation Work Measured by Defense Needs

Bill passed by House authorizes $24,823,000 for jobs important to national defense. Similar procedure may follow on flood control.

Taking up the suggestion made by the President when he vetoed the river and harbor authorization bill (*ENR*, May 23, 1940, p. 697) the House this week passed a bill authorizing $24,823,000 of navigation projects considered important to the national defense. Most of these projects improve access to military bases, munitions plants, and aircraft factories; one—Oswego Harbor, N. Y., $1,000,000—will furnish coal to an important power plant. Among the larger projects are:

Kennebec River, Maine	$2,000,000
Boston Harbor	2,300,000
Corpus Christi, Tex.	2,700,000
San Diego Harbor	3,875,000
Los Angeles and Long Beach Harbors	7,074,000
Keehi Lagoon, T.H.	3,300,000

The bill would also authorize any project costing less than $3,000 considered necessary to the national defense and would authorize construction of an irrigation distribution system in Central Valley, California.

It is not unlikely that a similar procedure may be followed on the pending flood control authorization bill. Application of defense criteria to flood

(*Continued on p.* 39)

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RALPH BUDD, CIVIL ENGINEER, ON DEFENSE COMMISSION

Ralph Budd, president of the Chicago, Burlington & Quincy R.R., has been named by President Roosevelt as a member of the National Defense Commission. Budd, who began his railroad career in 1899 as rodman on the Chicago Great Western to later become assistant engineer of that line, in 1902 joined the Rock Island Line, later becoming division engineer. He was appointed chief engineer of the Panama R.R. in 1906 and two years later chief engineer of the Spokane, Portland & Seattle R.R. In 1913 he joined the Great Northern becoming successively chief engineer and president. He became president of the C. B. & Q. in 1931.

FWA To Be Key Unit In Defense Program

The defense program presents the first real test of the coordinating function which the Federal Works Agency was created a year ago to exercise. John Carmody's small staff is devoting a major part of its energies to liaison between the works agencies and the war and navy departments. On FWA agencies, particularly WPA, will fall much of the auxiliary defense construction, such things as roads into air bases and cantonments, housing around arsenals, munitions plants and the like.

Arthur Morgan Returns To Dayton-Morgan Company

Arthur E. Morgan, former chairman and chief engineer of the Tennessee Valley Authority, has returned to the presidency of the Dayton-Morgan Engineering Co., a position from which he resigned in 1933 to go to the TVA. In the reorganization of the Dayton-Morgan company that has just taken place, Carl A. Bock and C. C. Chambers became vice-presidents with Chambers acting as general manager. Offices of the company have been moved from Dayton to nearby Yellow Springs, Ohio. The company maintains its association with the Morgan Engineering Co. of Memphis, of which L. L. Hidinger is president.

Carl A. Bock, who returns to the company as vice-president, also resigned from it in 1933 to go to the TVA, ultimately becoming assistant chief engineer and later chief consulting engineer. Bock resigned from the TVA in November 1939. He joined the Morgan Engineering Co. in 1913 and later became office engineer on the Miami Conservancy District work.

C. C. Chambers, who began his association with the company in 1907, has been chief engineer of the Muskingum Conservancy District since 1934. He was with the Electric Bond & Share Company from 1926 to 1928 and with the Hudson River Regulating District from 1928 to 1930. Robert E. Gohl, who has managed the company since 1933, has been compelled to withdraw from active work on account of ill health.

Harris & Ewing Photo

Arthur Morgan

All-American Canal Used To Serve Earthquake Area

A section of the All-American Canal has been placed in service to carry water across the New River gorge to supply water for a large area affected by the earthquake of May 18, which destroyed a 900-ft. flume of the Imperial Irrigation System across the same stream in Mexico. The section of the All American Canal now used carries water from a point east of Calexico on the Central Main Canal of the Imperial district to a point several miles west on the West Side Canal of the same district. At the time of the earthquake the only water in the All-American Canal was that in the section leading from Imperial Dam on the Colorado River to Pilot Knob, a section about 20 miles in length. Only minor earthquake damage has been reported for the All-American system as a whole.

Allegheny County Unions Move to Cut Building Cost

The AFL building trade unions of Allegheny County, Pa., in an effort to stimulate construction of private dwellings, reduced wages of all members on June 1 by 20 per cent. The new rates follow a contract signed by the

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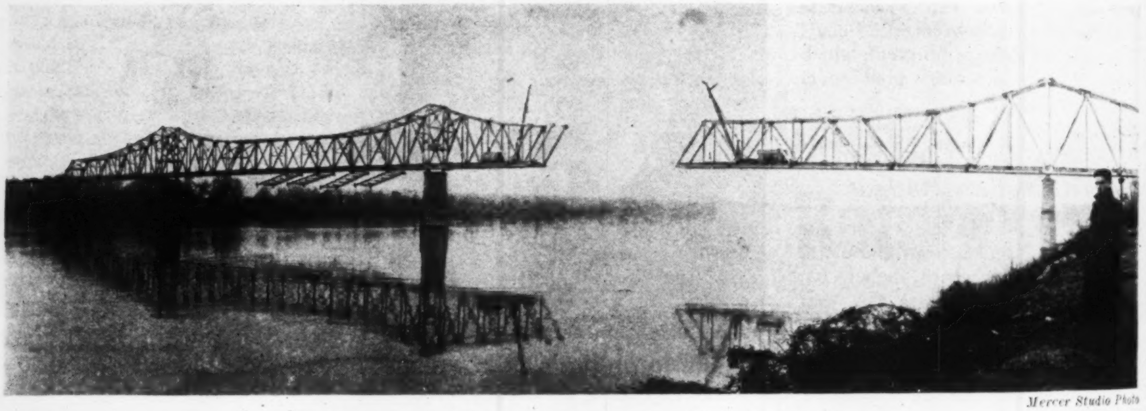


Mercer Studio Photo

BRIDGE PULLS UP ITS "LEGS" WHEN ICE THREATENS

Sometime this month the new Ohio River bridge at Owensboro, Ky., will be opened to traffic. A notable bridge from either a size or cost standpoint it is most interesting for an incident that occurred during its construction last winter. At that time the far channel span was supported on four steel falsework bents resting on piles which were suddenly threatened by a bad ice condition in the river. Hurriedly closing the span and swinging it free of the falsework the contractor sought some way to save the falsework itself. The solution is shown in the above illustration. Extending the bridge several panels into the next span he ran his traveler out on this cantilever as a counterweight and then pulled the falsework bents up under the span as shown. When ice conditions permitted new steel to arrive, erection continued and the falsework bents were removed.

A multiple cantilever structure of four river spans (343—629—751—278 ft.) the bridge will cost about $1,730,000, financed by revenue bonds of the Owensboro Bridge Commission and a PWA grant. It affords a two-lane roadway of concrete filled steel grid type on the main spans and of 7 in. solid concrete slab on the anchor spans. The Indiana approach consists of 2,000 ft. of steel girder and deck truss spans and a 3½-mile embankment road. Modjeski & Masters were consulting engineers on design and construction supervision with W. C. Gorman as resident engineer. Substructure contractor was the Dravo Corp. and the superstructure was erected by the Hunter Steel Co. R. E. Johnson represented the PWA.

Building and Construction Trades Council and the Master Builders' Association. The contract, which will apply to about 20,000 union members, contains provisions for preventing strikes and similar work delays.

• • •

Navigation Projects

(Continued from p. 37)

control projects would probably imply an emphasis on local protection in critical areas at the expense of river-control projects. It would also mean concentration on manufacturing centers such as the Connecticut and Ohio valleys and Los Angeles County rather than on the Mississippi or Red rivers.

Even a very substantial increase in the standing army is not likely to raise any important personnel problems in the Corps of Engineers. Long-standing plans are available for bringing into the civil functions retired engineer officers and national guard officers unsuited to troop duty. War Department spokesmen deprecate any move to reduce flood control activity under emergency conditions and point to the trouble that might have been caused if a flood of 1927 proportions had occurred during the last war.

Cut in Federal Works Forecast

President's proposal to reduce non-defense expenditures by 10 per cent likely to affect many projects.

R. B. Colborn, ENR Washington Bureau

The President's proposal to cut an average of 10 per cent from non-defense expenditures during the coming fiscal year is still in such a preliminary stage that estimates as to where cuts may be made are largely speculative. If the plan goes through it will avoid the possibility that Congress might make a horizontal cut in departmental expenditures.

There is no present intention to cut federal salaries. Departmental payrolls may be cut, however, by failing to fill positions that become vacant. Since economies here and in other features of the operating services would not add up very fast, it is probable that appropriations for civil works construction would be the first target of those charged with making the 10 per cent cut.

An attempt to assess the effect of the plan on construction can begin by eliminating certain possibilities. The public housing program and the federal-aid road program are legal obligations of the federal government and cannot be reduced easily, if at all. But this is not the case with direct federal expenditures for roads in forests and parks, or for parkways, and such work is especially vulnerable because the 1941 appropriation of $31,000,000 is 25 per cent above 1940; it is therefore likely to be cut.

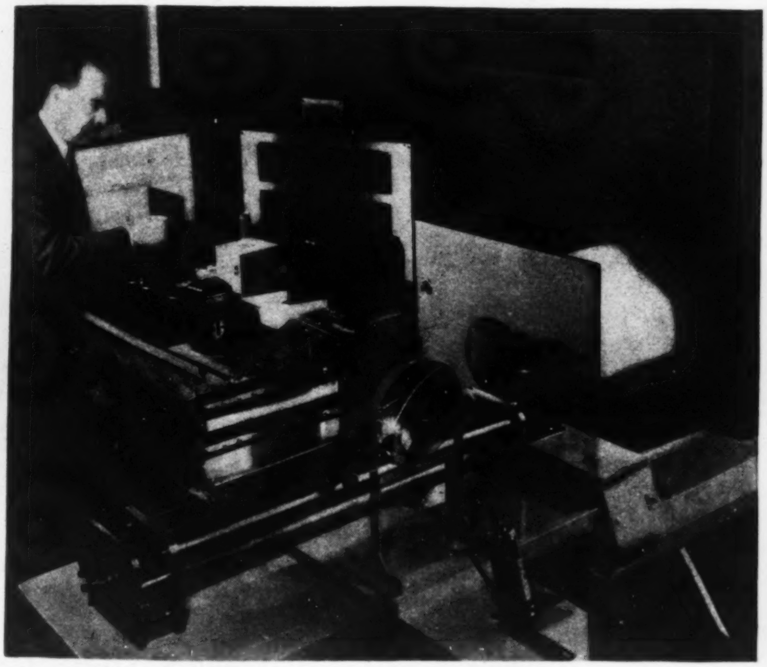
As to power, the administration has so frequently expressed its conviction that national defense requires the provision of additional power that substantial cuts are unlikely in funds for TVA or other works offering early prospect of power production. An exception might be Kentucky Dam, whose completion is far in the future.

Public buildings in 1941 are scheduled to receive little more than half of the amount provided for the fiscal year just ending, and a large portion of the reduced amount is for buildings in Washington. The need for the latter would be increased by the emergency, and therefore substantial cuts are unlikely in this item.

Army engineers may resist cut

First thoughts in connection with economy usually turn to the flood control and navigation appropriations. At present, however, the Corps of Engineers is in a strong position to resist cuts because its appropriations for 1941—$70,000,000 and $24,000,000 respectively—are only about half those for 1940. It is possible nevertheless that some projects in both groups may be postponed; in the field of navigation improvements, procedures for segregating those projects that have defense value are already being worked out, while in flood control the projects of greatest defense value are local protection works, which are comparatively small items. Larger projects still far from completion, such as Denison Dam, may be slowed up or stopped. Similarly the Ohio and Mississippi programs might suffer.

Reclamation expenditures are quite likely to be cut. What reduction there is in the 1941 appropriations as compared with 1940 is due mainly to completion of projects, and Reclamation can show little defense value for most of its undertakings. Grand Coulee, which is talked of as a site for munitions plants, may be in the list of exceptions. On the other hand Central Valley could show no benefits for a long time in the future, and this and other projects might be selected for reductions.



NEW EARTHQUAKE ANALYZER DEVELOPED AT M.I.T.

A NEW MACHINE for studying the wave records of earthquakes by photocell scanning has been developed at Massachusetts Institute of Technology by Arthur C. Ruge, professor of engineering seismology. Seismograph records are converted into electrical impulses which are amplified to represent the swaying of buildings of varied vibration characteristics, depending upon the setting of the controls. Ruge is shown adjusting the apparatus.

Chicago to Spend Millions For Transit Facilities

Following consummation of the Chicago transit unification plan, announced in these pages last week, Philip Harrington, Commissioner of Subways and Superhighways, states that $60,000,000 will be spent in the next three years for rehabilitating present transit facilities and for the purchase of new equipment. An additional $42,000,000 will be spent in the following five years, mostly for new rolling stock.

Harrington hopes that the referendum vote necessary to approve the transit unification can be held by Aug. 1. The city ordinance for establishing a single transit company to operate all surface, elevated and subway lines is now being prepared for consideration of the city council.

Details of the expenditures planned for the next three years are as follows:

New rolling stock:	
550 subway-elevated cars	$14,000,000
900 street cars	14,600,000
640 buses	6,400,000
Surface line improvements:	
Track and electric system	4,250,000
Shops, car barns, etc.	2,000,000
Rapid transit lines:	
Elevated block signals	5,000,000
Subway track and stations	5,000,000
Rehabilitate elevated structure	2,125,000
Elevated track changes	2,000,000
Extensions elevated platforms	1,870,000
Shop equipment	1,025,000
Improve 440 present elevated cars	830,000
Other elevated changes	900,000
Total	$60,000,000

• • •

Agreement on New Roads In Grand River Dam Area

An agreement has been reached by the Oklahoma State Highway Commission, the Bureau of Public Roads, and the Works Projects Administration for the construction of new roads to replace those to be inundated in the Grand River Dam area. Although details of the agreement have not yet been announced, the agreement tentatively provides that the Highway Commission will sponsor the project, the Bureau of Public Roads will pay for the work from Oklahoma's allotment of federal-aid funds, and that the work will be done by a contract management plan.

The principal roads affected are U. S. highways 58 and 60. It may be necessary to designate state route 10 a Federal highway so that Federal funds may be expended on that particular road.

No agreement has been reached regarding the flooding of a sewage disposal plant and city park at Miami, Okla.

BRIEF NEWS

The legality of an $18,000,000 bond issue approved April 23 to finance rehabilitation of Philadelphia's water system was upheld in the common pleas court last month. The case is being appealed to the Pennsylvania State Supreme Court for final test.

Income from machinery rented to a Michigan user by a Michigan dealer is not subject to the 3 per cent state sales tax, the state board of tax administration has notified the Michigan Construction Equipment Dealers' Association, adding, however, that rentals on machinery from a source outside the state of Michigan are subject to the state use tax of 3 per cent on the income from rentals.

Bids Called for Long Dam In Yazoo Flood Basin

Bids are being called on construction of Arkabutla Dam at the headwaters of the Yazoo River in Mississippi. Construction is to be carried out under the direction of the district engineer, U. S. Engineer Office, Vicksburg, Miss., as part of the general plan for flood control on the lower Mississippi. Bids are to be opened June 25 at Vicksburg.

Arkabutla Dam is to be built on the Coldwater River, a tributary of the Yazoo, in the northwestern part of the state, not far from Sardis Dam. It is to be a rolled earth fill, 10,000 ft. long, excluding the north ridge dikes, and 65 ft. high above the valley floor. An outlet structure of the gate type will be constructed near the existing stream channel and a spillway will be built through a ridge at the north abutment.

JOBS OF THE WEEK

BUILDINGS, CANAL ZONE

Novey & Lutrell, Ancon, C. Z., was awarded the contract for buildings at Fort Amador, Fort Clayton, Albrook Field, Corozal, $498,997. J. A. Jones Construction Co., Charlotte, N. C., got the contract for buildings at Mount Hope and Fort Randolph. Bids for work at Fort Sherman (Contract D) were rejected; contracts for buildings at Fort Kobbe and Howard Field were held for later award.

NATIONAL GUARD ARMORY, WASHINGTON, D. C.

C. H. Tompkins, Washington, D. C., will construct a drill hall and heating plant for the Guard Armory (first unit) under a $1,182,000 contract.

GAS PIPE LINE, PENNSYLVANIA

Williams Brothers Corp., Tulsa, Okla., will build a natural gas pipe line in western Pennsylvania for Manufacturers Gas Co., Kane, Pa., $1,800,000.

HOUSING PROJECT, PORTSMOUTH, OHIO

The 260-unit Wayne Hills Housing Project at Portsmouth, Ohio, will be built as a USHA project by W. A. Sheets & Sons, Inc., Fort Wayne, under a $977,000 contract.

CHESAPEAKE AND DELAWARE CANAL BRIDGE

Penker Construction Co., Cincinnati, Ohio, is low bidder (to U. S. Engineer Office, Philadelphia) on the substructure for the new highway bridge on the Coleman Du Pont Highway over the Chesapeake and Delaware Canal at St. Georges, Del.; $931,500. It will be recalled that a freighter wrecked the old lift bridge at this location in January, 1939. The new bridge will be a high level structure, its 540 ft. tied arch main span clearing shipping by 135 ft. Plate girder approaches bring the total length to 4,600 ft. In keeping with the highway, one of the most modern in the country, the bridge will have divided roadways 23 ft. wide. Total cost will be about $2,500,000. Engineers are Parsons, Klapp, Brinckerhoff & Douglas, New York City.

HOUSING PROJECT, ELIZABETH, N. J.

Andrew Christensen, Elizabeth, N. J., was awarded the contract for construction of a 405-unit project for the Elizabeth Housing Authority.

NOTE—Additional bidding and contract news on over 600 projects, large and small, appears in the Construction News Section beginning on page 117.

Battle Headlines Recall Engineers' Role in Last War

The stirring news from France of the drive of the German forces down the valley of the Somme River past Cambrai, Arras, Peronne and Amiens recalls to many engineers who served in the American Expeditionary Force in 1917 and 1918 that members of the engineer corps of the American Army helped the British stop the German drive toward the Channel ports in the spring of 1918. Men from the 6th Engineers who were rebuilding a bridge at Peronne and men from the 12th Engineers, a St. Louis unit, who were building light railways behind the British front were hastily thrown into the nondescript army known as "Carey's Chickens" that stopped the drive before it cut the lines of communications at Amiens. Operation of the light railways in the area immediately north of that occupied by these men was in the hands of the 14th Engineers, a Boston unit.

Late in 1917, in the same area, the 11th Engineers, a New York regiment, had sprung to national fame by its participation in the fighting at Cambrai, which was the first battle in which masses of tanks were used by the British to reverse the process of the present war by breaking through the German lines. Men of the 11th Engineers were not in the area in the 1918 drive but were brought back to dig trenches for the new defense line back of Arras. The 12th and 14th were continued on railway reconstruction and operation on the new front and were joined by the 16th Engineers.

Highway Funds For 1942-43 Slashed by 25 Per Cent

House authorization is $178,500,000 for each year; increase by Senate not expected.

Federal highway expenditures authorized for fiscal 1942 and 1943 were cut in the House this week 25 per cent below the amounts recommended by its road committee, bringing the totals authorized for each year to $178,500,000.

How funds are divided

The percentage reduction was applied to each category of expenditure; federal aid to primary roads is set at $93,750,000, to secondary roads at $18,750,000, and to grade crossing elimination at $37,500,000. These amounts will be allocated to the states and become obligations of the government. Authorized in direct federal expenditures in each of the two fiscal years is $10,500,000 for forest roads, $7,500,000 for parkways, $5,625,000 for roads in national parks, $3,000,000 for Indian roads, and $1,875,000 for public lands roads.

There is little likelihood that these amounts will be increased in the Senate.

Defense roads

Successful use in Europe of 70- and 80-ton tanks has accelerated the trend in military thought here towards constantly heavier equipment, but there is no disposition to retreat from the view that a highway bridge designed for an H-15 load is adequate for all military needs.

It is believed unlikely that this country, which now has nothing heavier than 20 tons, will go up to the tonnage of the European monsters, since these are primarily for attacking fortifications. By stretching the factors of safety, an H-15 bridge will take something like a 50-60 ton load, and military and civilian officials agree that if the Army develops heavier loads than these it will have to provide the means of handling them—through special carriages or the like to spread the load or through portable bridges (the engineer corps now has a 23-ton pontoon bridge which, by doubling up the pontoons, can carry 50 tons). In any case, railroad bridges designed for locomotive loadings will easily carry anything yet reported.

Weak bridges a problem

But where the increasing military emphasis is likely to have an effect on highways is in the choice of projects. From a military point of view the big weakness of the road system is the multitude of old weak bridges on major highways. Bridge replacement projects will probably be given priority over such operations as paving and widening.

The Public Roads Administration, which must approve all federal-aid projects, has the power to enforce such priorities and is now studying measures to do so. Lists of the bridges which ought to be replaced are on file.

Austin Co. Photo

DEFENSE BUSINESS ON THE INDUSTRIAL BUILDING FRONT

The Austin Company, with the largest volume of engineering and construction work under way since its establishment in 1878, has just set up these additional engineering facilities in Cleveland, Ohio. This corps of more than 150 draftsmen and engineers supplements the staff of 250 engineers at the company's general offices and district offices, which are located in principal cities throughout the United States and Canada.

OBITUARY

Robert C. Alloway, 61, partner in the Spokane, Wash., contracting firm of Alloway & Georg, was killed in a highway accident May 31 while on his way to Missoula, Mont., where his firm is building a $500,000 hotel. Alloway had been in Spokane since 1899, entering the building contracting field in 1908.

Henry Fairchild Greene, 69, former construction supervisor for the Pardy Construction Co., Bridgeport, Conn., died May 25, at Bridgeport. Greene, who had been associated with the construction industry for more than 40 years, served recently as construction superintendent for the city of Bridgeport on low-cost housing work.

John W. Reid, 68, consulting engineer of Detroit, Mich., died in that city May 26. Reid, who had training both as a lawyer and engineer, served the city of Detroit for thirty years, including seven years as commissioner of public works and one year as city engineer. Reid was president of the American Society for Municipal Improvements in 1927. For four years he was state senator of Michigan. Recently he had acted as engineer for the Michigan State Tax Commission.

Herbert Thomas Routly, 63, former chief engineer of the Ontario Department of Highways, died in Toronto May 24. Routly, a graduate of the University of Toronto in 1907, first practiced as one of the pioneer land surveyors in northern Ontario. In recent years he operated the Routly Construction Co. at Toronto.

John V. Neubert, 63, chief engineer of maintenance of way for the New York Central R. R., died June 4 at his home in New York City. Neubert, a former president of the American Railway Engineering Association, had been with the New York Central more than 40 years, joining the line soon after graduation from Pennsylvania State College in 1899.

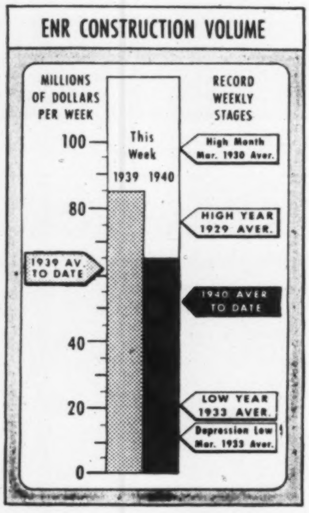
J. D. Trammell, 82, consulting engineer in charge of the design and construction of Fort Worth's present water supply system, died last month in that city. After graduation from Alabama A. & M. College, Trammell was employed by the Missouri Pacific Railroad and later by its subsidiary the International-Great Northern Line.

Ora J. Brookshire, 69, city engineer of Lebanon, Ind., and former surveyor, died May 25 in that city.

CONTRACTS AND CAPITAL

Engineering construction awards for the week total $64,967,000, 5 per cent above the weekly average for the 23-week period in 1939, and 24 per cent higher than the average for the current year. The total is, however, 23 per cent lower than the high volume for the corresponding week last year.

The week's awards bring the 1940 construction volume to $1,201,820,000, a level 15 per cent under the 23-week period last year. Private awards for the period are 15 per cent higher than a year ago, but public awards are 25 per cent lower.



Comparisons with the 1939 week show losses for the current week in private construction, 27 per cent; and in public construction, 22 per cent.

Highway lettings total $32,156,000 for the week, the highest volume reported since April 13, 1939. In addition to streets and roads, sewerage, waterworks and public buildings top their respective totals of a week ago; and commercial building and large-scale private housing exceeds its 1939-week volume.

New capital for construction purposes totals $15,866,000 for the week, a decrease of 15 per cent from the volume reported for the corresponding week last year. The current week's financing is made up of $8,945,000 in corporate security issues, $5,821,000 in state and municipal bonds, and $1,100,000 in RFC loans.

New construction financing for the year to date, $597,269,000, is 33 per cent lower than a year ago.

(Weekly Table on page 35)

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY ENGINEERING NEWS-RECORD, IN MAY, 1940

Engineering News-Record *reports projects of the following minimum costs: — water-works, excavation, drainage and irrigation,* $15,000; *other public works,* 25,000; *industrial buildings,* $40,000; *other buildings,* $150,000

Five Weeks — Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Mid West	West of Mississippi	Far West	United States			Canada
								Five Months		
Public Works							**May 1940**	**1940**	**1939**	
Waterworks	171	1,680	1,078	222	1,048	1,475	**5,674**	34,450	104,756	146
Sewerage	37	2,488	249	3,886	1,183	302	**8,145**	38,928	80,797	58
Bridges, public	78	6,140	539	368	1,377	579	**9,081**	44,049	69,068	325
Earthwork and waterways	156	1,872	29,399	558	14,909	3,246	**50,140**	112,011	64,589	461
Streets and roads	2,511	14,449	9,379	14,021	16,494	5,775	**62,629**	293,254	270,659	2,319
Buildings, public	1,418	11,589	11,465	5,238	3,535	1,000	**34,245**	152,652	302,039	707
Unclassified, public	797	2,478	12,652	1,324	607	1,875	**19,733**	69,309	73,282	9,720
Total public	**5,168**	**40,696**	**64,761**	**25,617**	**39,153**	**14,252**	**189,647**	**744,653**	**965,190**	**13,736**
Federal government (included in above classifications)	473	7,251	44,875	476	15,774	4,671	**73,520**	165,597	103,283	....
Private										
Bridges, private	....	2,339	....	....	410	....	**2,749**	3,287	2,311	....
Buildings, industrial	4,108	4,962	3,712	19,320	3,575	3,618	**39,295**	171,323	73,215	1,614
Buildings, commercial	4,075	15,794	6,749	8,975	3,835	1,800	**41,228**	167,093	163,994	4,060
Unclassified	50	766	570	403	2,741	4,847	**9,377**	50,497	90,119	770
Total private	**8,233**	**23,861**	**11,031**	**28,698**	**10,561**	**10,265**	**92,649**	**392,200**	**329,639**	**6,444**
Total Engineering Construction:										
May, 1940 (5 weeks)	**13,401**	**64,557**	**75,792**	**54,315**	**49,714**	**24,517**	**282,296**	....	....	20,180
April, 1940 (4 weeks)	10,365	62,599	38,512	43,116	39,333	17,891	**211,816**	....	....	15,388
May, 1939 (4 weeks)	10,645	83,116	44,066	49,651	44,758	20,756	**252,992**	....	....	9,512
Five Months — 1940	51,491	290,934	235,053	210,077	218,455	130,843	....	1,136,853	....	55,382
Five Months — 1939	74,981	428,502	192,213	240,790	239,783	118,560	....	....	1,294,829	31,432

Federation of Engineers Hold National Convention

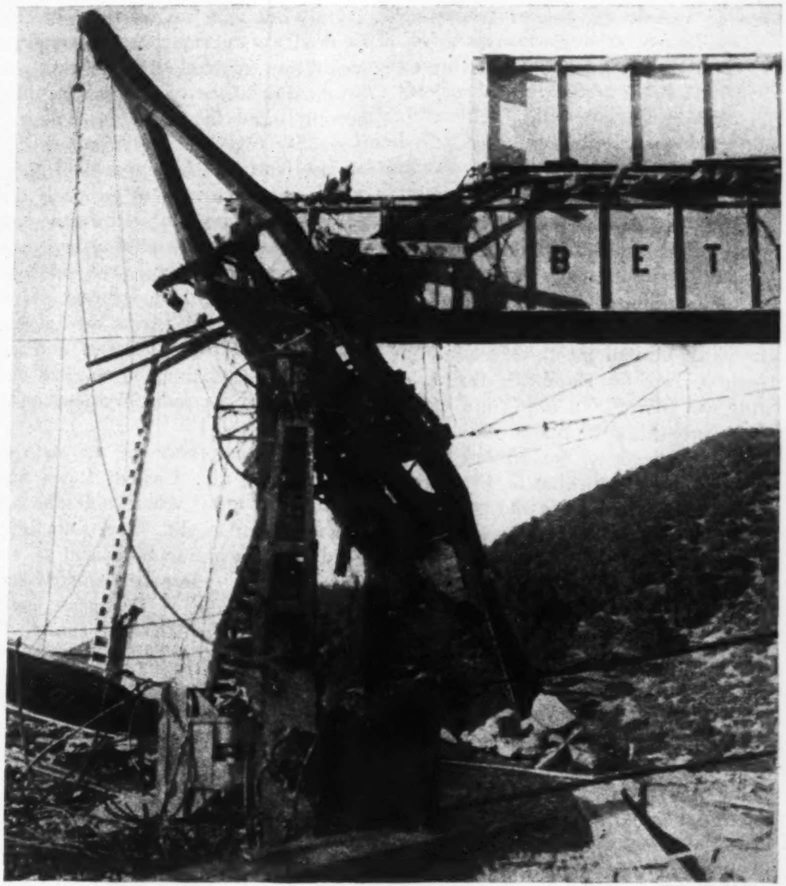
The Federation of Architects, Engineers, Chemists and Technicians, CIO, held its Fifth National Convention in New York, May 31-June 2. Fifteen chapters were represented, including representatives from three chapters on the Pacific Coast and one in Denver.

Interest at the convention was centered largely on the effect of war preparedness on American industry.

In the civil engineering field the highlight of the meeting was a talk by Stanley M. Isaacs, borough president of Manhattan, on civil service as a career. On the matter of union membership, Isaacs said that men in city employment could join any union they chose or need join none. Union officers representing such men, he added, must be concerned with public welfare as well as that of their members.

Among the resolutions adopted was one calling for the compilation of data on job classifications and salaries to aid the chapters in working out agreements with employers. The officers of the federation were authorized to take up this subject with the Founder Societies.

The principal officers were reelected, Lewis A. Berne, president; James A. Gaynor, secretary-treasurer; and Marcel Scherer, vice president in charge of organization.



Wide World Photo

DERRICK ON SHASTA RAILROAD RELOCATION WORK WRECKED

A DERRICK being used for erecting steel for the second Sacramento River crossing for the relocation of the Southern Pacific around the Shasta Dam reservoir site toppled from the bridge late last month and was completely wrecked. A two months delay in the relocation work may result.

During the erection of the two 100-ft. girders shown in place in the above view, the derrick rested on top of two trusses 18 ft. apart. When these girders, which are but 8 ft. center to center, were in place the derrick moved out onto them, supported by outrigger beams to which the guy cables were attached. As lifting of one of the 50-ft. girders required for the next span was begun, the hoisting engineer from below saw the lashings slipping, warned nine workmen out of danger and had one end of the girder on the ground before the derrick fell. No one was seriously injured.

Building Construction Slumps in Mexico

Building construction in Mexico, excepting some government and private work that was started some time ago, has slowed down to almost a standstill because of economic and other conditions attendant upon a presidential year.

Some forecasts are that this condition will continue until after the election July 7. Others in a position to judge what may be expected see no great resumption of work until after September 1, when the new president is scheduled to take office.

In contrast to the building situation the federal government continues pushing construction on the four trunk railroads that were begun in 1936 in an effort to finish by the end of this year or at least early in 1941. Dam construction, irrigation work and highway operations begun by the federal government are also being continued.

• • •

Ralph F. Proctor Dies; Leader in Surety Bonding

Ralph Fenno Proctor, 62, manager of the Fidelity and Surety Department of the Association of Casualty and Surety Executives, died in Baltimore on May 29, following an operation for an acute gallbladder attack a few days earlier. He was one of the leading figures in surety bonding, having been engaged in this field for nearly thirty years, first with the Maryland Casualty Co. and later with the Association.

A native of Massachusetts and a graduate of Cornell, Proctor was in engineering and contracting during the first twelve years of his business life. In 1913 he joined the Maryland Casualty Co. and served successively as chief engineer, manager of contract bonding, and vice-president in charge of all bonding. The World War interrupted his surety activities, as he entered the Constructing Quartermaster organization and directed the construction of Camp Meade, the Curtis Bay Ordnance Depot and other war plants, rising to the rank of lieutenant-colonel. Rejoining the Maryland Casualty Co. after the war, he continued there until 1935, when he took charge of fidelity and contract bonding for the association, with office in New York.

For many years Proctor worked toward improving the service of surety bonding and making it a more active force in sound construction practice. He was one of the organizers of the Bureau of Contract Information. From 1903 to 1919 Proctor was a member of the engineering firm of Williams, Proctor and Potts, New York City.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Why Housing Costs Are High

Sir: Your issue of March 14 carried an editorial "Cut Housing Costs." It might stimulate activity in real reduction of housing costs to restate the major causes which have kept costs up. Main factors in high costs are:

1. High interest rates despite apparent FHA lower rates. Building money still costs about 6 per cent though FHA and Housing Authority money is borrowed at rates of ¼ of 1 per cent to 1½ per cent. Interest is a continuing cost for twenty-five years. A 2 per cent per annum reduction would save nearly half the cost of a house during its life.
2. Building labor cost is all out of line with the wages of the laborer who is to buy or rent the dwelling. The majority of men in this country earn less than $4 per day. They cannot exchange that day for $8 to $15 per day demanded by building trades.
3. Jurisdictional disputes and resistance to use of scientific methods and shop fabrication. Resistance against training apprentices.
4. Archaic building codes which embody ancient practices and favor many special materials and outworn and unnecessary safeguards.
5. Combines of material men in restraint of trade.

To lower costs, the above factors must be changed or eliminated; otherwise there will be increasing clamor for housing by subsidy. That will lead to political football and vote juggling. The subsidies, by the way, actually go to the protected banks, unions, and material men and are paid by all taxpayers for the privileged groups.

JACOB MARK
Professional Engineer
Brooklyn, N. Y.

Mosquito Fighting

Sir: I was delighted to read the article relative to the permanent anti-malaria drainage operations conducted by the city engineer of Memphis (*ENR*, April 25, 1940, p. 602). Mr. Fowler has done a very good piece of work.

Recently I have been giving a series of lectures to college chapters of the American Society of Civil Engineers—two in Mississippi and two in Louisiana. Yesterday came a letter from the president of the Tulane student chapter saying that the seniors in the engineering school had been previously unaware that it was the engineer's job to permanently wipe malaria out of their state. It all goes to show how extremely important is the assistance being given to engineers by such articles as the recent one on culvert design in *Engineering News-Record.*

J. A. LE PRINCE
U. S. Public Health Service (retired)
Memphis, Tenn.

A Plea for Real Maps

Sir: The recent publication of a map of Paraguay, prepared by the general staff of the army on a scale of one-millionth and showing all roads and trails throughout a country with limited means of communications and few facilities for accurate mapping is an important event. For one thing it places this small country ahead of the United States in map procedure, that is, in making maps that are maps in the true sense—a reduced scale picture of the real earth surface.

It is perhaps accurate to say that our average citizen knows a map merely as a convenient diagram, illustrating by simple lines the relationship of various localities and the routes of travel between them. Formerly these lines were the railroads, and roads were seldom noted, but now the reverse has occurred and no one could suppose from an inspection of an automobile route map that there were such things as railroads in existence. Useful as are the road maps given away by the oil companies and those prepared by the automobile associations and the state highway departments, I have seen none that could be called a real map of the country traversed. They merely indicate how to go from place to place by the best road. They show the roads only in a conventionalized way by broad colored lines that ignore local changes of direction and hardly ever show the minor horse and buggy roads. One cannot tell from them the condition as to curvature or grade, and frequently not even whether the route is in hilly or flat country.

The only maps that contain such information—the U. S. Geological Survey topographical sheets—are seldom used by the public, and if consulted are soon rejected because they have not been revised since our new motor roads were built; also the sheets are of unsatisfactory size and material for travelers' use. Actually, only a part of New York and New England has been reduced from these maps to form two sheets of the one-millionth map of the world.

Only one who has worked with the Geological Survey has a complete realization of the immense task, in proportion to the resources available, accomplished by this able organization. Since 1882 it has been engaged on the National Topographical Map. At the average rate of progress the map will not be done before the end of this century. Something less than half of our continental area has been produced on published sheets. Also, many of the early sheets are inaccurate and lacking in detail and all need revising to include changes due to growth of communities, new roads, etc.

The contrast between the state of mapping in the United States and that of Europe is remarkable and not much to our credit. It is sometimes said that such a comparison is not fair to us in view of the smaller size and greater age of European countries. As to size it is fair enough to compare France or Germany with our Northeastern States from Maryland to Maine. Great Britain is larger than New York and Pennsylvania. But these foreign countries have been accurately mapped for a century and more, and a publisher there can produce any type of commercial, property or road map by using the official government survey map as a base and superimposing the information desired, as is done on their automobile maps.

Those of the A.E.F. who had occasion to use the French military maps will recall their marginal lists of officers responsible for the original surveys a century ago and the additional notation of later dates of revision. The Michelin maps for motorists were based on the 1—200,000 military sheets, with highways of varying importance emphasized by a color scheme and with additional markings to indicate steep grades, sharp curves and items of interest to the tourist, such as picturesque views. Dissected into convenient sized rectangles and mounted so as to fold conveniently, they seem in recollection the ideal maps to one tired of trying to puzzle out a route on our clumsy and fragile folders on a windy day. The scale too (about 3 miles per inch) is an adequate mean between our too large geological sheets and the oil company maps.

On the basis of results to date, Paraguay may well be credited with a spirit of map consciousness rather more advanced than that of the United States, for its entire area has been included in a map on the millionth scale, and there is also a motor guide book with maps showing all routes which can be traversed. It is true that there are no paved roads as yet, a shortcoming that we are attempting to remedy, but considering comparative resources the Paraguayan efforts on map making show much greater interest than can be credited to the North American Republic.

Henry Welles Durham
Manager, R. W. Hebard & Co., Inc.
Asuncion, Paraguay

CIO Construction Contracts

Sir: In your issue of May 2, p. 11, under the heading of "CIO Contracts Signed by Contractors in Heavy Construction Field," the following appears: "In New York, the CIO has already taken one contract away from the powerful local 3 of the AFL electricians, signing up the Electric Underground Construction Co., which was formerly AFL. Penner, the electrical contractor who recently brought a sensational suit against Local 3, has also gone CIO."

Local Union No. 3 has not had any contract with any company by the name of Electric Underground Construction Co., therefore, the CIO could not have taken the contract away from Local No. 3.

Harry Van Arsdale, Jr.
Business Manager
Local No. 3, International Brotherhood of Electrical Workers

Investigation of the CIO claim that it had taken away a contract from Local No. 3 following receipt of Mr. Van Arsdale's letter indicates that the claim is without foundation. The Construction Workers Organizing Committee has signed a contract with the Electric Underground Construction Company but as yet that company does not appear to have invaded the New York stronghold of Local No. 3—Editors.

Promoting the Profession

Sir: Many comments have appeared in your publication recently regarding the publicity or lack of it afforded the engineer. As a student soon to embark on a career in engineering, I have avidly consumed these, and, with all due deference to the engineers who have commented, I should like to offer an opinion.

Engineering projects, however small they be, have a direct influence on society, and the engineer by his supervision of these projects should assume an important and prominent position in the community he serves. Yet, unfortunately, too often he is either oblivious of these social aspects of engineering or incapable of dealing with them.

It is not meant to infer here that the engineer is inherently an unsocial individual, but rather to question the "shortsightedness" of engineering educators who have failed to recognize what many sociologists and economists have long maintained: the logical position of the engineer is being a prominent member of the community, and these educators have failed to prepare him to assume this position.

The average engineering school's curriculum, (and I have examined several) makes but scant provision for the cultural development so vital to the full development of any profession as it affects the individual, and as it serves to provide a common meeting ground for members of the various professions.

Indeed, recall the minority of engineers who have achieved a degree of prominence and you will find the men who have not stagnated in their personal and social advances for having been too much absorbed in their technical progress.

The various engineering societies have recognized the need for adjustment and have recommended liberalization of the curricula, but response is slow.

Ultimately, the solution lies in requiring a two-year pre-engineering school education in a course of liberal science, as in medicine and law, and consigning the more advanced technical topics to the graduate school.

When the engineer begins to be aware of his proper position in his community and assumes this position, it must follow that his community in turn will become aware of his services and give due acclaim. Only by the proper education will this be realized.

Simon A. Greenberg
Brooklyn, N. Y.

Engineering Insignia

Sir: Your item on p. 47 of the Feb. 29, 1940, *Engineering News-Record*, about the school of engineering that wants suggestions for an emblem ". . . to symbolize its field and function," challenges my imagination.

"Engineering" has come to mean to young men of today: An office; a desk; a drafting board; and good pay without the requisite labor and concentration to really earn that pay. Consequently, my suggestion for the emblem is:

> An outline background of a railway locomotive, with a man in overalls tightening some bolt with a large wrench; superimposed over this, keep the T-square and triangle design of their present emblem; and around the margin, printed in capital letters of drafting-room style: "WORK + BRAINS + STUDY = SUCCESS IN ENGINEERING."

It was that thought that prompted me to seek an apprentice job with the Western Electric Company's Engineering Department in 1920, as soon as I had finished my four years in high school. It has been that same idea that has kept me attending night-school classes ever since.

As to the measure of my success, it is yet to come—perhaps after another twenty years of work and night-school training. Still, I do not feel that I have been unsuccessful, in that I have made slow but steady progress thus far, and have been able to be never out of a job for longer than a few weeks during the past twenty years.

William E. Kirkendall
Los Angeles

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June 6, 1940

OUR FIRST LINE OF DEFENSE is on the industrial front. An important statement by James H. McGraw, Jr., president of the McGraw-Hill Publishing Co., on the problem of mobilizing industry for action and sustained speed appears opposite p. 80 of this issue.

On Their Own

IN A RECENT NOTICE to prospective bidders on a sewerage job at Wellman, Ia., the engineer, H. R. Green, prefaced his letter with this statement: "No PWA, no WPA, no special assessment bonds; straight municipal contract paid in monthly estimates, the job to be started immediately and completed Sept. 1, 1940. We estimate the project should cost $30,000." Here is a straightforward declaration of independence, worthy of emulation by city officials everywhere. The sooner municipalities get back on their own the more stable will be our whole financial economy.

Something New in Buildings

A NEW IDEA and a new material are embodied in the Star garage, newest Washington building. The material is a thin concrete wall slab, strong, durable and architecturally effective. The new idea is the use of a rigid lacework curtain of these slabs to enclose the building. Both have large possibilities—the curtain idea because of its simplicity and effectiveness for purposes of partial enclosure, the thin slabs because of their structural qualities, which evidently go beyond the field of mere curtaining into that of strength service in frame and shell. Such slabs were used as facing in the Navy's model basin at Carderock and in one of the Merritt Parkway bridges, and are to be used in the Naval Medical Center. Their strengths of 8,000 to 10,000 lb. per sq. in. supplemented by reinforcement invite utilization of the material as a major structural element rather than facing. With strength plus weather resistance and adaptability to varied esthetic effect the slabs have a combination of qualities unique in the structural field.

Contract Problems Ahead

PREPAREDNESS is certain to place heavy responsibilities on construction. Demands on the contracting industry are likely to come suddenly, and when this happens we may have to go through some of the same confusion that was witnessed in 1917. Even without this, however, there are troubles ahead for contractors, as pointed out by the late Ralph F. Proctor in an address which we have abstracted briefly. His emphasis on the value of advance precautions against contract difficulties is timely. Legislative aid is unlikely in view of the tendency of government to assume that construction needs no mobilization or advance planning. An emergency construction board set up by the industry itself can be of value, however, and in the meantime contractors can exercise prudence in bidding by taking account of unforeseen developments.

River Control

MULTIPLE-PURPOSE RIVER CONTROL is well advanced on the Colorado River in Texas, as outlined elsewhere in this issue. Covering flood control, power, irrigation and improved domestic supply, operation difficulties are sure to arise. What these difficulties may be was shown by the controversy that arose over the way water storage was handled at Buchanan Dam, the one reservoir whose construction was far enough advanced to store water in the flood of July, 1938. On the one hand, the Lower Colorado River Authority was criticized for having held too much water in the reservoir before the flood came, and on the other for having released the stored water at a rate that caused damage below the dam when it was evident that a bad flood was in the making. This happening serves to emphasize, first, the importance of adequate knowledge of rainfall and expected runoff, and second, the need for skill and independence in operating such river regulatory facilities.

Earthquake Throw

NOT FOR MANY YEARS has a substantial amount of horizontal shear displacement accompanied an earthquake within our boundaries. Reports of the Imperial Valley disturbance of two weeks ago tell of displacements comparable with the displacement that occurred along the San Andreas rift during the San Francisco earthquake of 1906. The difference in damage is doubtless due in part to the fact that the Imperial Valley cities offer less opportunity for destruction, but part of the credit must be given to the attention that earthquake-resistant construction has received during recent years. One demonstration of this was seen in the survival of tank towers designed in accordance with conclusions drawn from the Long Beach earthquake, and the failure of tanks not so designed. Such experiences emphasize the value of seismic design.

Get Ready for Airports!

AIRPLANE TALK so far has greatly outstripped any mention of airports. On the basis of first things first this is perhaps natural, yet even before Europe's war or the President's "50,000 planes a year" brought the military plane into prominence aviation events in this country had emphasized the inadequacy of our airport facilities.

Consider some of these events. Several weeks ago the commercial airlines of the country completed a full year without a fatality, presaging more and more air travel. At about the same time the Army announced that it is building a 70-ton airplane with a 212-ft. wing spread, and the Navy followed with announcement of progress on a 75-ton flying boat 200 ft. wide between wing tips. Then came news that delivery was being made on the first four-engined Stratoliner; bigger than any commercial land plane in the country it will seat 33 people. By 1941 the first of several 42-passenger ships will be completed, and one airline company is sponsoring a design competition for a 70-ton, 150-passenger ocean liner.

Further news was that nearly 200 plane arrivals and departures are being chalked up every 24 hours at the recently opened North Beach air terminal in New York; that Chicago's airport is almost as busy, and that smaller city ports have activity relatively as great. In contrast to news of great advances in plane design and air travel the Civil Aeronautics Authority announces that we have only 1,824 civilian airports, whereas we need 3,500, and that just 31 of the present ports can handle military aircraft. What all of this means to airport design is of vital concern to civil engineers and construction men.

So far, airport problems have been regarded rather complacently. After all, airports involve grading, paving, drainage, buildings, with all of which the profession is intimately familiar. But is it as simple as that? For example, as planes got larger, longer runways were required. Then came the idea of a tricycle landing gear, which permits a ship to take off more quickly, and shorter runways seemed in prospect. But blind instrument landing was developed and longer runways were again desired as a safety measure; blind landing required too that runways be made wider. Also, ships continually get heavier; wheel loads go beyond any experience with trucks on the highways. Again, airports become show places, attracting huge crowds of sightseers, and thus create a traffic and parking problem. And more recently national preparedness provokes consideration of the differences between military and civil ports as regards both design and location.

The plain lesson is that the civil engineer must add to his many responsibilities that of keeping abreast of airplane development. Under the pressure of increasing air travel and of military necessity a great era of airport building is ahead. It will afford a great opportunity, but it is a challenge for the construction industry to acquire the knowledge to build the best.

Nature Never Quits

NEED for the engineer's services on a particular job rarely ends when construction is finished. More likely than not his talents will be required steadily or intermittently, according to the kind of works erected, so long as these works continue to function. For operation and maintenance are engineering jobs that in many cases demand skill, ingenuity and knowledge of the highest type.

How the Los Angeles aqueduct has been kept in operation over a long period of years in the face of the destructive forces of nature affords an outstanding example of the maintenance engineer's art. As described in this issue, emergencies have had to be met where the consequences of a mistake would have been far more serious than any delay during the initial construction. Between emergencies the day by day inspection to ward off trouble has required careful planning and devotion to duty. The article contains not only a fund of information for the specialized tasks of maintaining pipelines, tunnels and reservoirs, but it turns the spotlight on a type of engineering whose importance grows as our engineering plant becomes more extensive and more complex. "Using and directing the forces of nature" is the engineer's birthright. And the forces of nature never quit.

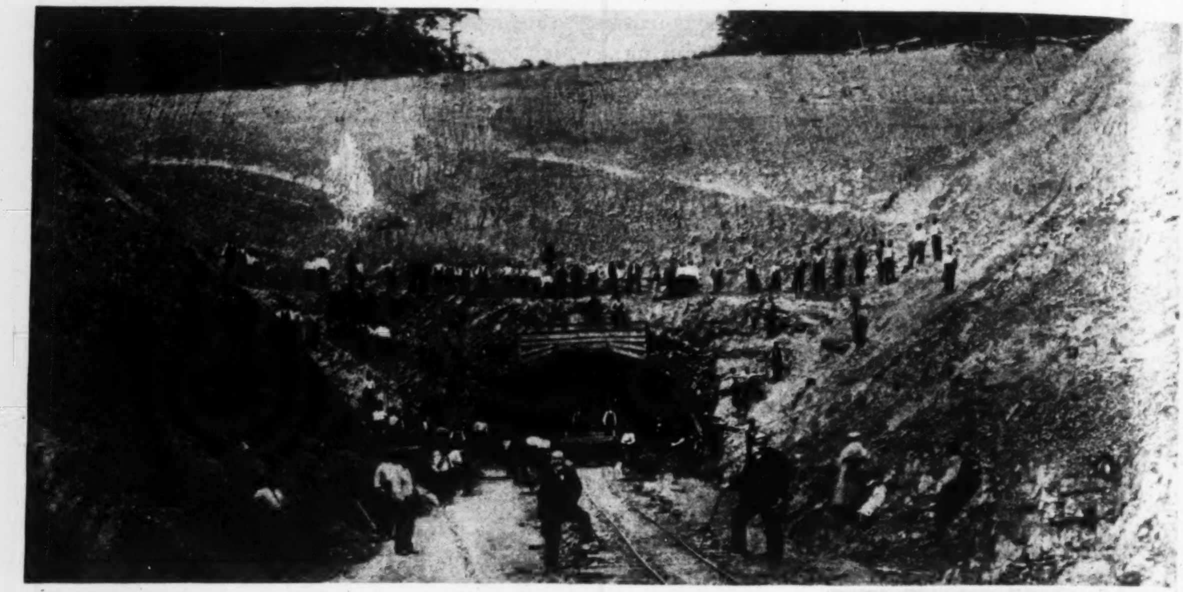


Fig. 1. Rays Hill tunnel 55 years ago (above) and at start of present job.

Tunneling On the Turnpike

***Contents in Brief**—Seven tunnels, totaling 6.5 miles, are being driven to carry the Pennsylvania Turnpike super-highway through the ridges of the Allegheny Mountains. Six of the tunnels are on the line of old railroad tunnels started more than 50 years ago for the South Penn Ry., and the previously driven headings were enlarged as part of the new tunnels. Design features include ventilation of the roadways, a flat arch roof, provision for resisting acid seepage waters and an egg-shaped concrete drain in trench beneath the floor. Construction interest lies in a fast schedule, handling high rock falls in the old headings, use of large drill carriages and shovels, and considerable muck haulage by truck and tractor wagons.*

MORE THAN FIFTY YEARS after contractors quit work on the tunnels of the ill-fated South Penn Ry., some 3 miles of headings they drove on six tunnels were enlarged as part of the bores that will carry the Pennsylvania Turnpike through the heart of the Allegheny Mountains between Harrisburg and Pittsburgh. The turnpike includes seven tunnels, but one contractor elected to drive a new tunnel alongside the old one because of the poor condition of the old headings. More than any other part of the project, the tunnels feel the terrific construction pace dictated by requirements to complete the 160-mile superhighway in twenty months, for they were recognized from the start as the bottlenecks of construction progress.

The seven tunnels aggregate 35,296 ft. in length, of which 1,082 ft. is in concrete lined sections extended outside of the ground. They vary in length from 3,511 ft. to 6,782 ft. Slightly more than half the total length is enlargement of single or double track headings previously driven for the railroad. Data on the tunnels, listed in order from east to west are given in the accompanying table. The proportion of new driving to total lengths varies from 12 per cent at Kittatinny to 100 per cent at Allegheny. On Tuscarora and Rays Hill tunnels the contract time specified was 295 days; on the other five it was 315 days.

Geological investigations

For the most part, the old headings provided an excellent opportunity to determine the geological structure of the tunnel sites. In a few instances rock falls had blocked access to the extreme interior of the headings, but drifts were driven to complete the investigation. Examination of the old headings was supplemented by 15,000 ft. of core borings.

The studies were conducted by Arthur B. Cleaves, geologist, who prepared a complete geological report on each tunnel. He found the geology of the tunnels so complex that generalization applying to all was impossible. All of the ground was found to be of sedimentary origin, divided into nineteen formations of shales and sandstones. Studies were made of the plastic flow, air slaking and probable pressures of each formation, on which data the design of the ground supports and permanent lining was based. Investigations revealed several possible trouble spots, such as a sand seam under 200-lb. hydraulic pressure in the underdriven section of Kittatinny tunnel. The design for this section called for a circular lining of heavily-reinforced concrete.

Another interesting study was that of acidity and alkalinity of the waters seeping into the old headings, as well as those considered as a source of supply. These investigations revealed pH values from 3.4 (highly acid) to 8.3 (highly alkaline). Special provisions were made in the design for drawing off the acid waters to prevent damage to concrete in the lining and floor, and of course sources of water for flushing and cleaning that showed low pH values had to be ruled out.

Tunnel design

The cross-section of the tunnel required enlarging the driven portions of the old tunnels. In the 50 years since the old headings were driven, weathering had caused considerable deterioration in the weaker rock, resulting in many falls. Some of these falls practically closed the old tunnels, in one case acting as a dam to impound a subterranean lake 14 ft. deep. Some sections of the old headings were timbered, found to be in various degrees of preservation, and dry masonry walls were found in a few cases, usually near the portals.

In the interest of economy, it was decided to utilize the old headings. Accurate surveys were made, and plans, profiles and cross-sections were platted and carefully studied by the designing engineers. The best use of the old tunnels was determined by study of various alignments and grades, using templates of the outline of the new sections superimposed upon the platted cross-sections. Some of the old headings had been started as single-track bores; others were driven part way as double-track size, then continued some distance as single track. In general, the invert and one side of the new tunnel coincide with those of the old heading. Turnpike engineers estimate that use of the old tunnels saved about one-third of the excavation required for all new tunnels, amounting to $2,000,000 at average contract prices.

While the turnpike roadway provides four lanes of traffic, opposing lanes are separated by a planted strip.

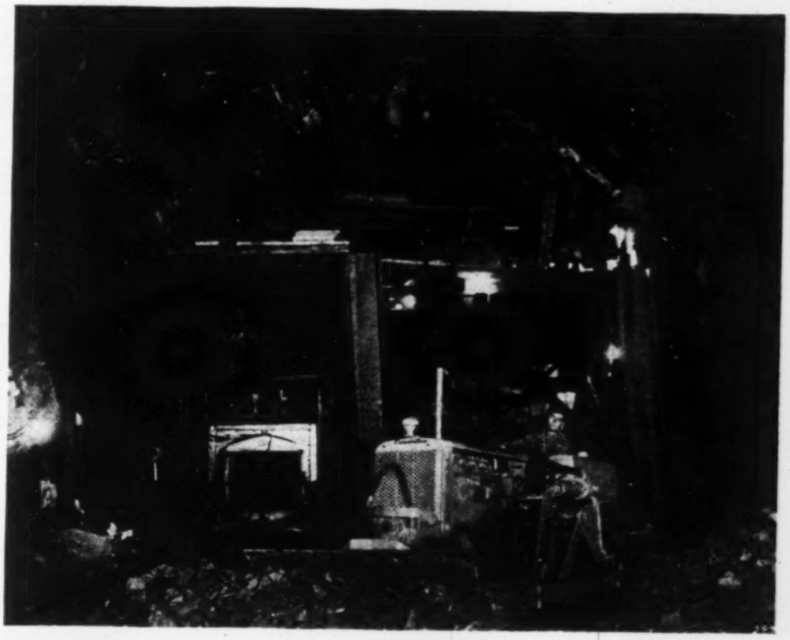


Fig. 3. Truck drill carriages were used on some of the tunnels. Illustrated is the Hunkin-Conkey job at Laurel Hill.

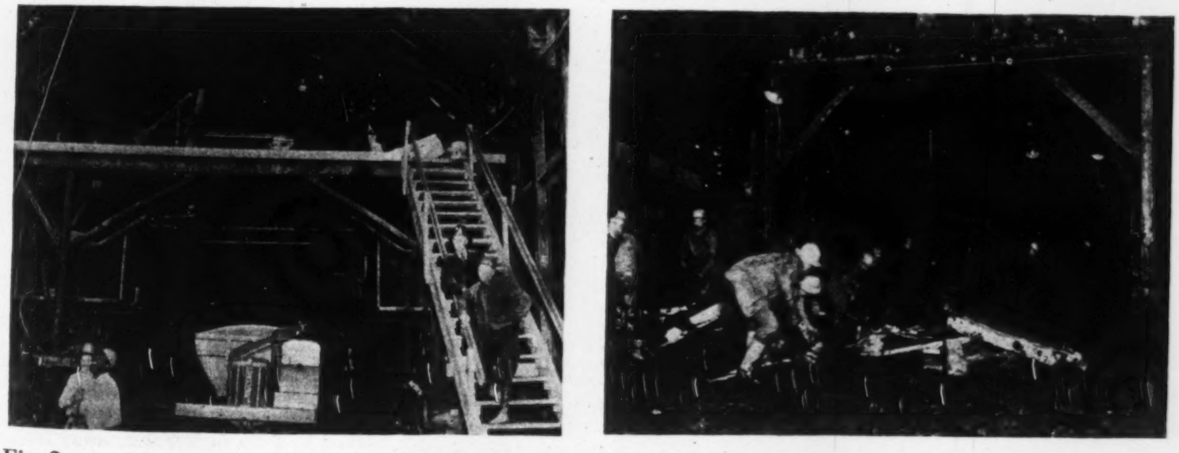


Fig. 2. Turnpike tunnels required rail-mounted drill carriages of unusual size. The jumbo at Rays Hill cleared the Dumptor haulage units. The stairway is an unusual safety feature. Rail haul of muck at Allegheny (right) called for a cherry picker on the jumbo. The cars were used in the Fort Peck tunnels.

the tunnels carry only two unseparated traffic lanes. The tunnel roadway is 23 ft. wide; curbs and a narrow sidewalk on one side bring the clear inside width to 28½ ft. The roof is arched, but a flat ceiling slab, supported by hangers, reduces the minimum overhead clearance above the roadway to 14 ft. 4 in. Space between the ceiling slab and roof will be utilized as a ventilation duct; air at the maximum rate of 175 cu. ft. per min. per ft. of tunnel will be blown into the roadway through ports in the ceiling slab from fans located at the portals; vitiated air will exhaust through the trafficway. Fan houses will be located at all portals except that the Rays Hill tunnel, because of its relatively short length, will be ventilated from one portal only.

Tunnel illumination will be from mercury vapor lights in the tunnel ceiling. Emergency lights, operated from motor-generator sets in case of power failure, will be located in corbels at the junction of sidewalls and ceiling.

The roadway in tunnel will be a 10-in. reinforced concrete slab laid over a 15-in. layer of rolled rock sub-base. The ceiling is a 5-in. slab. In standard sections the walls and arched roof will be reinforced concrete of 18-in. minimum thickness. Where steel ribs are used as roof supports, they are set with outside flange on the back line of arch concrete; wood timbering is set entirely outside the minimum concrete lines.

Treatment of rock fall areas in the old headings varies according to conditions. Sometimes, in case of sound rock remaining above the fall, the arch is thickened to 20 in. and protected by a cushion of dry packing. Again, in cases of disintegrated rock around the void, the opening is filled with granulated slag, or is filled with lean concrete, or timber or concrete piers and walls are built above the arch to support the roof. Where a large fall has occurred in the sidewall, usual treatment is to build a tight wall of 2-in. timber lagging outside the concrete line and backfill the void with dry packing.

Drainage

Unusual attention has been paid to draining the tunnels. Carried in a trench excavated below invert level is a 2½ x 3½-ft. egg-shaped drain of precast concrete pipe bedded in lean concrete. The invert of the pipe is paved with bituminous mastic. An 8-in. vitrified pipe drain, set in stone fill, runs along the back toe of the sidewalls, connected to the main drain by tile drains laid in crushed stone at frequent intervals. Drains from the roadway curb lead into the cross drains.

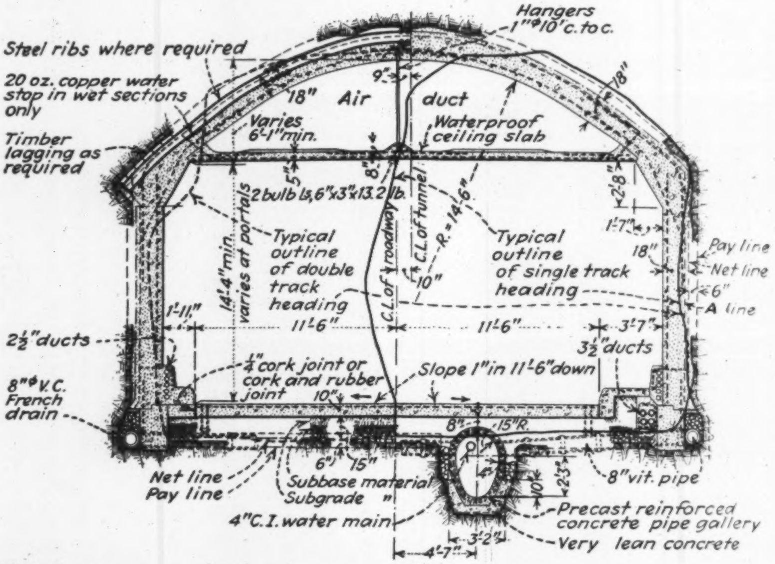

Hangers
1"φ 10' c. to c.
Steel ribs where required
20 oz. copper water stop in wet sections only
Timber lagging as required
18"
Air
duct
9"
18"
Varies 6'-1" min.
Waterproof ceiling slab
5"
8"
2 bulb ls, 6"x3"x13.2 lb.
2'-8"
1'-7"
14'-4" min. varies at portals
Typical outline of double track heading
C.L. of roadway
C.L. of tunnel
R.=14'-6"
10"
Typical outline of single track heading
18"
Pay line
Net line
6"
A line
1'-11"
11'-6"
11'-6"
3'-7"
2½" ducts
3½" ducts
¼" cork joint or cork and rubber joint
10"
Slope 1" in 11'-6" down
8"φ V.C. French drain
8"
15"R.
6"
15"
4"
10"
2'-3"
8" vit. pipe
Net line
Pay line
Subbase material
Subgrade
4" C.I. water main
Precast reinforced concrete pipe gallery
3'-2"
4'-7"
Very lean concrete

Fig. 5. Typical cross-section of the Turnpike tunnels. Note the attention paid to drainage by use of a large center drain and French sidewall drains. Acid seepage water requires special drainage facilities at certain spots.

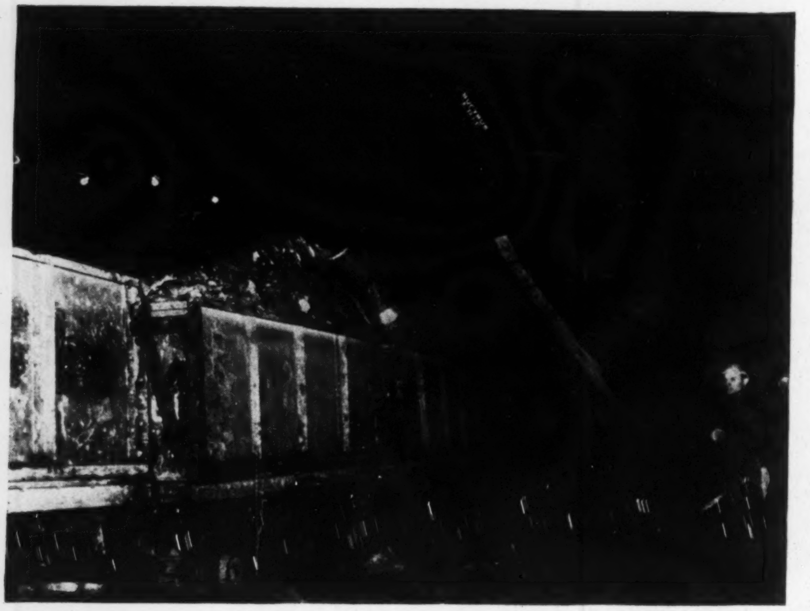
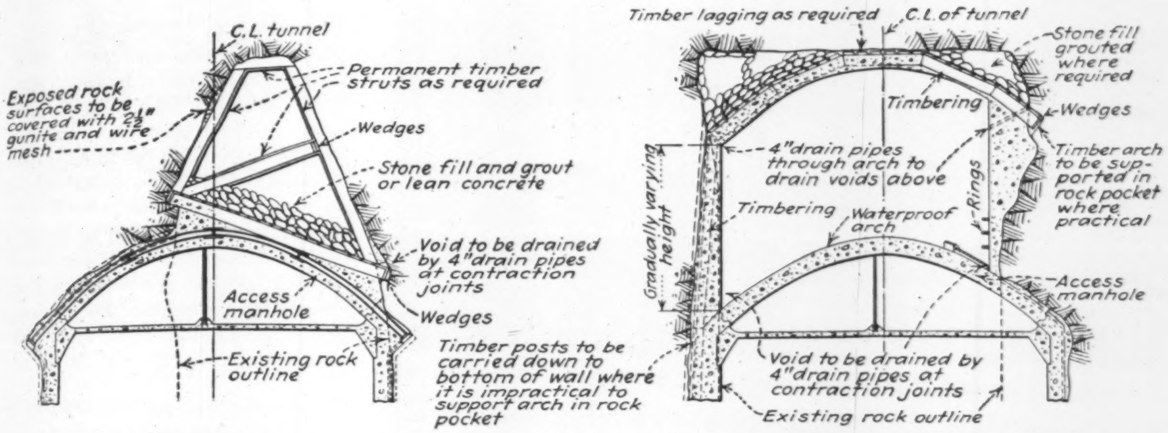


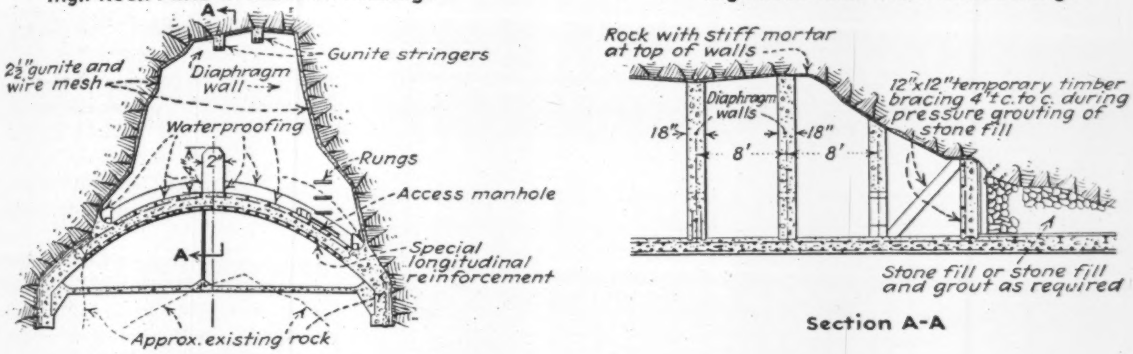
Fig. 4. Electric shovels did most of the mucking. Here is full-face driving at Allegheny by Guthrie-Marsch-Peterson.

In wet areas, steel pans, $\frac{3}{16}$-in. steel sheeting or wood lagging is placed over the arch ribs, outside of the concrete line, to protect the arch concrete. Lagging of 2-in. planks, set tight, is set along the wall areas, back-packed with stone to provide a French drain to the outside wall drain pipes. Where the seepage water is highly acid, vitrified drains are installed from the water seams to the side drains, and every precaution is taken to keep such waters away from the structural concrete. Where possible the top of the arch is protected with steel plate tunnel lining. Copper


C.L. tunnel
Permanent timber struts as required
Exposed rock surfaces to be covered with 2½" gunite and wire mesh
Wedges
Stone fill and grout or lean concrete
Void to be drained by 4" drain pipes at contraction joints
Access manhole
Wedges
Existing rock outline
Timber posts to be carried down to bottom of wall where it is impractical to support arch in rock pocket
Timber lagging as required
C.L. of tunnel
Stone fill grouted where required
Timbering
Wedges
4" drain pipes through arch to drain voids above
Timber arch to be supported in rock pocket where practical
Gradually varying height
Rings
Timbering
Waterproof arch
Access manhole
Void to be drained by 4" drain pipes at contraction joints
Existing rock outline

High Rock Falls in Old S.T. Headings

High Rock Falls in Old D.T. Headings


A
2½" gunite and wire mesh
Diaphragm wall
Gunite stringers
Waterproofing
2'
Rungs
Access manhole
A
Special longitudinal reinforcement
Approx. existing rock
Rock with stiff mortar at top of walls
Diaphragm walls
18"
18"
8'
8'
12"x12" temporary timber bracing 4' c. to c. during pressure grouting of stone fill
Stone fill or stone fill and grout as required

Section A-A

High Rock Falls in Old D.T. Heading

Fig. 6. High rock falls in the old railroad headings were taken care of by several methods. Here are typical treatments for single and double track sections.

waterstops are required in all transverse joints in the lining, and cork, or cork and rubber joints are placed between roadway slab and sidewalls.

Ground support

Very little timber ground support is being used. Most contractors have standardized in a roof support of 8-in. 31-lb. wide flange steel beams in two curved segments, bolted at the crown, supported on 8-in. 24-lb. wide flange posts, and spaced as required. The rock is blocked to the ribs with wood blocking and wedges. Wood lagging, placed above the outside flange of the ribs, is used if needed. Wall plates are seldom used. Where dry packing is called for behind the sidewalls, the wood lagging is placed directly against the outside flange of the posts.

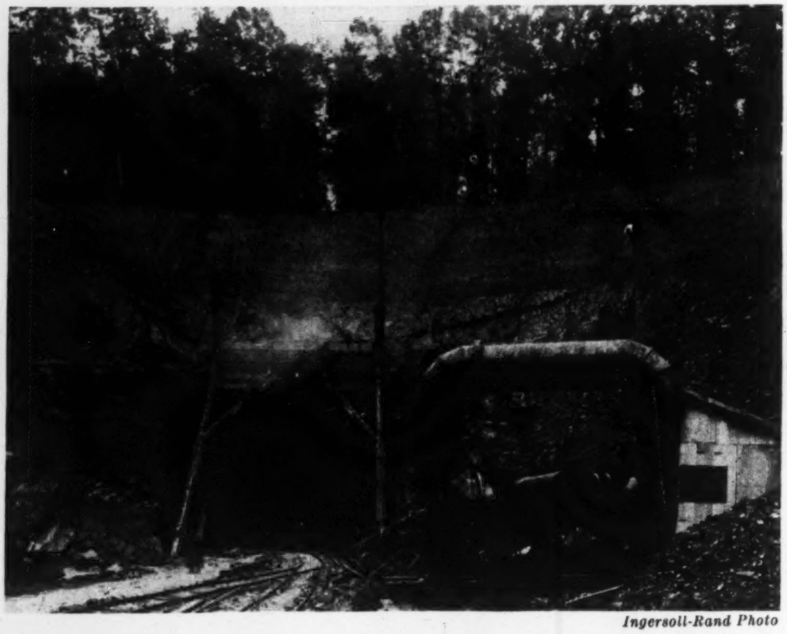
Naturally with six contractors on the seven tunnels, construction operations vary from job to job. The fast schedule, the large excavation dimensions of 34x24 ft., permitting the use of unusually large equipment, and the enlarging of the old headings are outstanding construction features of the underground work.

The drill carriages are some of the largest used since Boulder Dam. Some of the contractors are using truck drill jumbos successfully, others tried them and then went to wide gage rail jumbos, still others used the latter from the start. Diesel truck and tractor wagon haul of muck predominates, though rail haul is used by some contractors. In the latter case, diesel locomotives are in use

TABLE I — PENNSYLVANIA TURNPIKE TUNNEL CONTRACTS

				Tunnel Length					
				Prev. Driven Ft.					
Tunnel	Contractor	*Contract Price	Price Per Ft.	Single Track	Dbl. Track	Total	†New Ft.	New % Total	†Total Length Ft.
Blue Mtn........	Bates & Rogers Const. Corp..........	$2,920,123	$322	1,335	1,727	3,062	1,277	27	4,339
Kittatinny........	Bates & Rogers Const. Corp..........	(Inc. in above)	322	2,162	1,870	4,032	695	12	4,727
Tuscarora........	B. Perini & Sons, Inc..................	2,055,939	338	2,077	1,690	3,767	1,559	28	5,326
Sideling Hill......	Arundel Corp..........................	2,444,527	354	2,047	1,200	3,247	3,535	51	6,782
Rays Hill.........	Mason & Hanger Co....................	1,549,718	417	1,505	913	2,418	1,093	29	3,511
Allegheny........	Guthrie, Marsch & Peterson...........	2,672,188	409	.....	.....	.....	6,070	100	6,070
Laurel Hill.......	Hunkin-Conkey Co....................	1,920,281	361	373	400	773	3,768	81	4,541
Totals........	....	....	..9	9,499	7,800	17,299	.....	...	35,296

*Includes cost of approach †Includes total of 1,082 ft. concrete lined section outside the ground.



Ingersoll-Rand Photo

Fig. 7. **Motorblower capable of supplying 12,000 cfm of air for ventilation at the west portal of Blue Mountain Tunnel. The 26-in. four-way valve permits forcing air to or exhausting from the heading.**

on one job. Diesel equipment for underground use has found a wider application on these projects than ever before in tunneling.

Some jobs were started by the heading and bench system in which the Conway type of mucking machine was used, but all were eventually changed to full-face driving with diesel and electric shovel mucking, except the east heading at Laurel Hill. The change was made to speed up driving, as the full-face method was found to be faster.

It is doubtful if utilization of the old headings contributed anything to the speed of driving. Enlarging was invariably done from the face, and drilling operations to remove that part of the cross-section remaining inside the new section line took just as long as on the full-face. Then, too, much of the previously driven headings required expensive timbering because of weathered rock.

Driving operations

Blue Mountain and Kittatinny—These are twin tunnels, only 650 ft. apart; a single contract for both was let to Bates & Rogers Const. Corp., Chicago, who placed Dave Agnew in charge. Excavation and enlarging of the two outer ends, East Blue Mountain and West Kittatinny, was sublet to Sammons-Robertson Co., of Huntington, W. Va., and Boxley Bros. of Orange, Va. Bates and Rogers attacked the two facing portals and are doing all of the concrete lining. The West Kittatinny portal was so isolated that a power line could not be readily built, so the subcontractor installed diesel-driven compressors, used a Lorain diesel shovel for mucking and diesel Koehring Dumptors for muck haul. Electric-drive compressors and an electric shovel were used at east Blue Mountain, but the haul was by Koehring Dumptors.

Rail-mounted jumbos

On the two adjacent headings, Bates & Rogers installed a rail-mounted drill carriage on a 20-ft.-gage track, and utilized a separate jumbo for setting steel. The jumbos were moved by a diesel bulldozer, which also cleaned up the fly rock. Muck was loaded by Marion 1½-yd. electric shovels into cars on 36-in.-gage track, hauled inside by storage-battery locomotives and outside by diesel locomotives.

In the narrow valley between the two tunnels, where the contractor has his field headquarters, flows Trout Run, water supply for the city of Shippensburg. Exceptional care has to be taken to avoid pollution of this supply, requiring extensive sanitary facilities on the job.

Bates & Rogers used forged bits with steel up to 18 ft. long in automatic feed drifters with 29 to 32-in. feed. The subcontractor however, used detachable bits on 14-ft. steel. Powder was 30 per cent gelatin. Ventilation was by a 12,000-cfm fan at each portal, connected to 24-in. spiral riveted steel pipe carried on the ground. The side drains were installed as excavation progressed, but the main center drain is excavated and installed after the arch and sidewalls are poured, just ahead of the floor slab construction.

Tuscarora Tunnel—B. Perini & Sons, Inc., of Framingham, Mass., used a large single truck drill carriage at each heading. The jumbo, of wood frame construction and equipped with three wing platforms, was mounted on pneumatic tires, which required a lot of blocking and outrigging to prevent excessive vibration. Drilling was with automatic feed drifter which used 12-ft. solid steel.

Muck was loaded by a Lorain electric shovel into 10-yd. Euclid diesel dump trucks, which only hauled about 5 yd. per trip because of the rough bottom. The trucks were turned near the shovel by backing around, though considerable manipulation was necessary to accomplish the turning. Ventilation was by a 15,000-cfm fan at each portal, connected to a 24-in. steel pipe. Fabric pipe was used near the face to facilitate handling during blasts.

Sideling Hill Tunnel—The Arundel Corp., Baltimore, Md., preferred two truck drill jumbos in each heading, each serving half the face. These were of pipe frame construction, set on 20-ton truck chassis. A system of blocking by jacks seemed to provide a stability not found on the other truck jumbos. Mucking was done in one heading by a Marion 1¾-yd. diesel shovel cut down and converted to electric operation; on the other a Lorain diesel, converted to electric power, was used. Euclid 10-ton diesel dump trucks did the hauling, handling about 7 yd. per trip.

Drilling was with automatic feed drifters using 3-ft. changes of solid steel up to 15 ft. long. The starter was usually 6 ft., as the truck jumbos could not be placed closer than 3 ft. to the face. From 2 to 3 lb. of 40 per cent gelatin per cu. yd. of rock was used as explosive.

Arundel kept the center drain within 300 ft. of the face. The trench was drilled with wagon drills by the heading drill crew, loaded and shot while the heading was being mucked out. It was excavated by a Marion diesel shovel. The pipe sections were placed at once, embedded in concrete hauled in by a transit mixer.

Something different in ventilation was practiced by this contractor in turning the air flow from a 20,000-cfm blower into the completed drain, which served as a vent pipe. From the end of the drain a fabric vent tube carried the air to the face. Auxiliary ventilation was provided by small blowers on the drill jumbos, exhausting through 6-in. pipes carried into the drilling zone.

Rays Hill Tunnel—Mason & Hanger Co., New York placed Geo. Mitchell in charge of the job; they sublet the open cut work to Vang Const. Co., Pittsburgh. This is the shortest tunnel on the project, and was the first to be holed through.

Drilling was from a rail-mounted carriage on 20-ft.-gage track. As an unusual safety measure, the jumbo was equipped with a sturdy stairway—not a ladder—at the rear. Muck was loaded into diesel Koehring Dumptors by cut-down Lorain electric shovels in each heading. During mucking operations the jumbo was moved back far enough to permit loaded and empty. Dumptors to pass each other between jumbo and shovel. The hauling rigs ran backwards or forwards with equal facility, and did not have to be turned around at the shovel. They hauled about 6 yd. per trip.

Mason & Hanger utilized underslung crown bars, hung by rollers from the last two or three completed ribs, to temporarily support the new rib until it could be bolted into place. Ventilation was by 18,000-cfm nonreversing fans at each portal, connected to 30-in. 20-gage steel pipe reinforced with angle bands. Change of direction of air flow was by manipulation of valves in the air pipe manifold near the fan. In cold weather air blown into the tunnel was heated by electric heaters.

The center drain trench was shot and excavated as the shovels moved out after holing through.

Allegheny Tunnel—Guthrie, Marsch & Peterson elected to drive an entirely new tunnel, 5,926 ft. long, rather than utilize the previously-driven 3,932 ft. of headings, which were in poor condition. Chas. Taylor is superintendent on this job.

Because of shallow overburden at the portals the headings were turned by driving side drifts at the springlines about 50 ft. deep, then cross cutting along the arch to permit setting of roof steel on wall plates in the drifts. Heading and bench driving was started at both portals and maintained until about 500 ft. had been driven at each end. Conway muckers were used in the top headings, Bucyrus-Erie electric shovels on the bench. The bench was drilled from horizontal bars, and muck was loaded into tractor-drawn Athey wagons, probably for the first time in tunneling.

However, speed requirements necessitated a change to full-face operations with a rail-mounted jumbo. Muck was then hauled in narrow-gage cars handled by storage-battery locomotives. Drilling was with detachable bits, sent away for resharpening.

Laurel Hill Tunnel—Hunkin-Conkey Const. Co., Cleveland, had to use side drifts for wall plates, along with a crown drift to open up the portals. The west heading was then developed to full-face driving, using two steel-frame truck drill carriages and narrow-gage rail haul. Muck was loaded by a Lorain electric shovel, and hauled out by diesel locomotives. The truck jumbos did not prove satisfactory—they took too long to move and set up—and were eventually replaced by a wide-gage rail-mounted drill carriage.

Drilling was done with detachable bits; from 70 to 90 holes 14 ft. deep pulled about 300 yd. per round with 500 lb. of 40 per cent gelatin. Ventilation was by a 15,000-cfm fan blowing into a steel pipe extended to the face by fabric tube.

At the east portal heading and bench, driving was continued until the tunnel was holed through. Conway muckers and rail cars handled the muck. Wm. Bennett is general superintendent for Hunkin-Conkey.

The tunnel design and construction is under the direction of Richard M. Merriman, chief tunnel engineer of the Pennsylvania Turnpike Commission.

Winner's Sewage Plant

A sewage treatment plant put in operation recently at Winner, S. D., to supersede an old septic tank installation, has some unusual features, according to *The Clarifier*, official bulletin of the State Board of Health. Following clarification in the primary settling tank (24 x 8 ft. and 7 ft. deep), the sewage flows by gravity to the central distributor of a circular, high-rate rock filter (22 ft. in diameter and 8 ft. deep). The flow between primary tank and filter is continuous, without the usual rest period used with most trickling filters. Distribution of the sewage over the filter is accomplished by motor-driven spray arms or splash plates upon which the overflow falls from a vertical influent pipe.

From the filter the flow is by gravity to the secondary settling tank for final sedimentation treatment. Thence it enters an outfall sewer of 12-in. tile, leading 8,800 ft. to a small creek. During periods of low flow, it is necessary to recirculate part of the sewage in order to maintain a fairly uniform rate of application to the filter. This is effected by pumping from the secondary tank back to the primary tank by means of a recirculating pump.

The method of handling and disposing of the sludge is said to have been used in only a few plants in this country. Endless-chain sludge removers in the two tanks carry the sludge to sumps from which it is pumped to a conditioning chamber or concrete tank, 4½ ft. square and 7 ft. deep. Here ferric chloride is applied (about 2,000 ppm) and is well distributed by mechanical mixers. The resulting mixture is run out on small drying beds. The pumping, mixing and drying operations are conducted daily in order to prevent septic action in the settling tanks. The treated sludge gives up its moisture readily and may be removed within 10 to 24 hours.

A Quarter Century of Aqueduct Maintenance

● How does an organization go about keeping a 240-mile aqueduct operating year in and year out? To get the answer, a member of *Engineering News-Record's* staff interviewed J. E. Phillips who, as engineer of maintenance and operation on the Los Angeles Aqueduct, has been responsible for keeping it in service for the past twelve years and knows intimately its 26-year operating history. In all this time there never have been restrictions on domestic or commercial water supply in the area this aqueduct serves. What happens when it is shut down for repairs and why it sometimes goes out unexpectedly, making continuity of supply dependent on storage, is told in this article.—EDITOR.

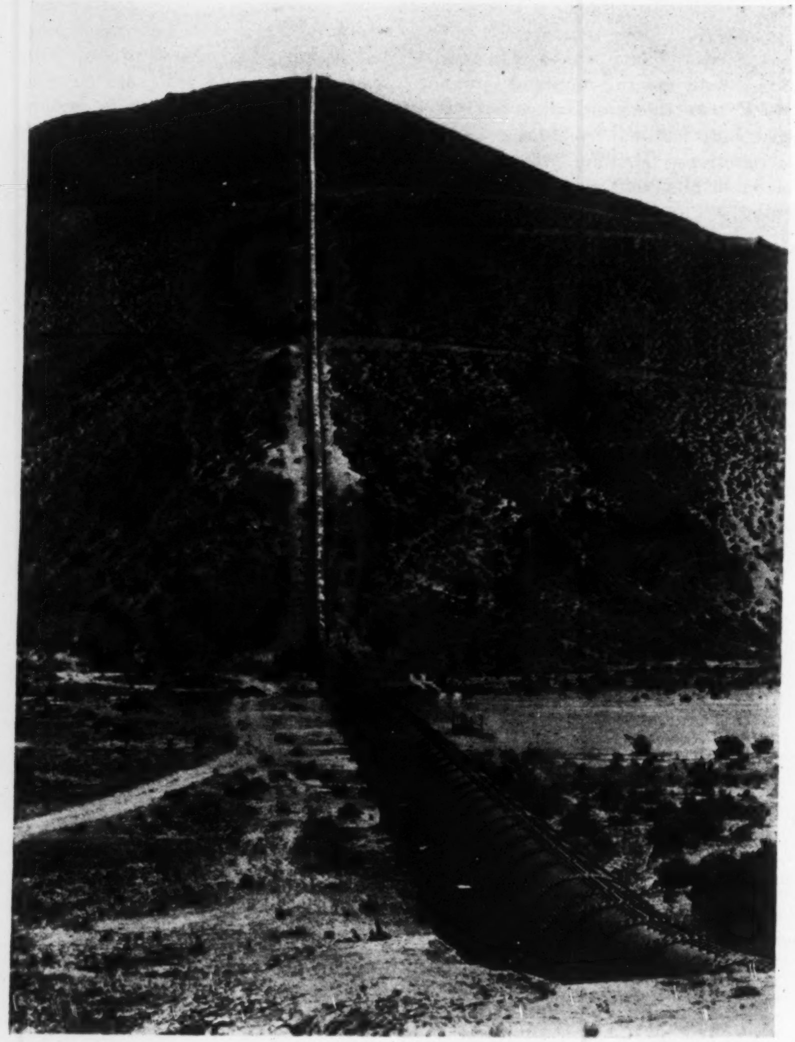


Fig. 1. South rise of jawbone siphon, an exposed 10-ft. steel siphon; static head is 850 ft. It is in the steel siphons of the Los Angeles Aqueduct that the most maintenance problems occur. Constant "breathing", abrasion by sediments, acid attacks and collapsing are among the sources of trouble.

FOR TWENTY-SEVEN YEARS the Los Angeles Aqueduct—some 240 miles of it, starting in the cold climates of high mountainous regions and extending across hot desert areas to the south coastal plain—has never failed to deliver at a time when the flow was needed to maintain the water supply in the city it serves. This outstanding record has not been just pure luck, nor can it be credited to the designers, because many maintenance problems could not have been foreseen when the aqueduct was built.

Realizing that valuable maintenance experience must have accumulated in the long period since construction was completed, *Engineering News-Record* made inquiry about it of the man most directly concerned, J. E. Phillips, engineer of maintenance and operation, working under H. A. Van Norman, chief engineer and general manager, Los Angeles Bureau of Waterworks and Supply. The history of experience outlined by Mr. Phillips is summarized in the following.

Conception of the scheme for bringing a Los Angeles water supply all the way from Owens Valley originated some 40 years ago with the late William Mulholland. Authorized by the citizens of Los Angeles in 1907, construction started in 1908 and was completed in 1913 at a cost of $24,500,000, somewhat under Mr. Mulholland's estimate. The original design took into account the probability of accidental interruptions and shutdowns necessary for maintenance by constructing storage reservoirs near the lower end sufficient to maintain service for several weeks. Other reservoirs along the line make it possible to shut down certain sections separately for short periods.

All the original safeguards have been useful and others have been added as experience has accumulated in meeting problems attendant upon extreme cold (minus 10 deg. F. at El. 4,000), extreme heat (120 deg. F. or more in the desert areas) and cloud-

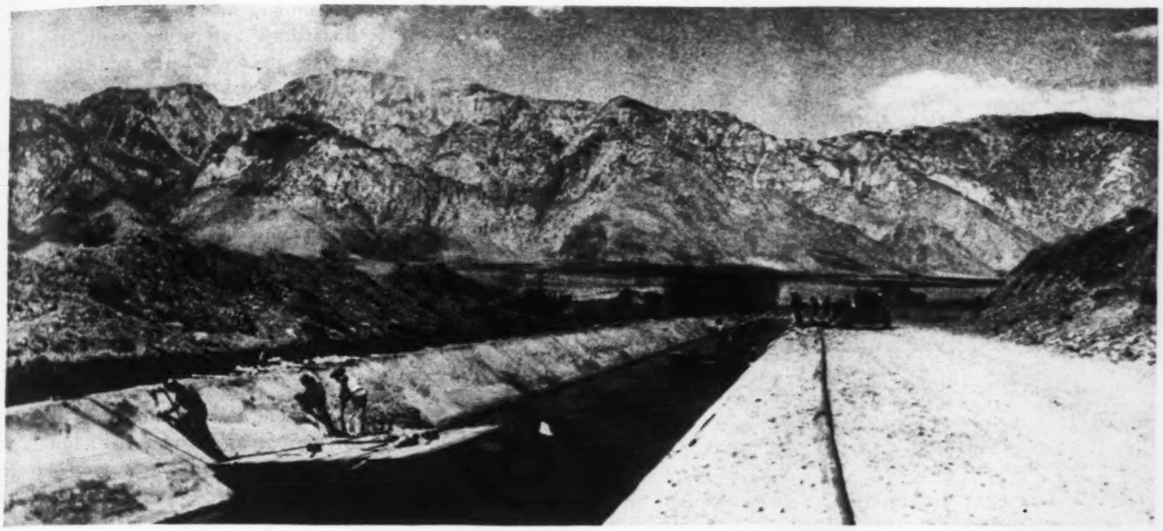


Fig. 2. **Cleaning loose material from sidewalls of concrete-lined canal in Owens Valley preparatory to relining. Mountains in background, some of which rise to 14,000 ft., are snow-covered through the winter.**

bursts that cause dry watercourses suddenly to become raging torrents.

Between the intake on Owens River, 18 miles north of Independence, and the lower end of the line in the San Fernando Valley, the aqueduct encounters a wide variety of climatic conditions, crosses the San Andreas earthquake fault and includes 24 miles of open unlined canal (Intake to Alabama Hills), 37 miles of open lined canal (Alabama Hills to Haiwee reservoir), 98 miles of covered conduit, 53 miles of lined tunnel, 13 miles of steel and concrete pressure pipe (siphons), and 8 miles of reservoirs. The capacity flow is 500 cfs.

Records and forecasts

A primary requisite in successful operation of such an aqueduct is an organization of well-trained, reliable men. The first responsibility of these men is frequent and careful inspection of the entire line to discover potential trouble sources and to make adequate records for reference.

On all periodic inspections, records are kept in log books, and regulations are very strict on this point. Patrolmen, whose "beats" may range up to 12 or 15 miles, according to conditions, must make at least one log entry daily. All gate operations and all events and activities that might be valuable for reference are noted. Log books, which are of a standard size, all go to the Los Angeles office twice a year to be photostated for the permanent records. These records have paid for themselves many times over in giving accurate information recognized in court cases and are often useful in looking back to co-relate cause and effect.

An illustration of the importance of these logs is in the regular tunnel inspection where cracks are always observed for progressive development. Cracks may mean nothing at all or they may give warning of important movements. The tunnel patrolmen carry a small quantity of cement, sand and water mixed to plaster consistency and a handful or "pat" of this is put over each crack under observation. The date is scratched in the concrete and the location is noted in the log. When this pat is again observed, there is sure to be a valuable indication of what has happened meantime. Decision on important repair work often is based on the effects that the cracking has upon these pats, as recorded in the logs.

It is highly desirable to forecast maintenance requirements for at least six months and if possible for a year ahead. Only twice a year, in the spring and the fall, can the aqueduct be taken out of service for any length of time (such as two or three weeks) for maintenance work. Thus the department must plan ahead and be fully prepared to do necessary work when the flow stops.

A major problem in the unlined canals is the deposition of sand and silt brought into the aqueduct in suspension. These deposits not only reduce capacity but they settle in curved, irregular shapes which create cross-currents and eddies that seriously damage the banks. Until recently the dipper dredge which constructed these open canals more than 30 years ago was the principal equipment used for removing deposits. The dredge could not deliver the spoil much beyond the edge of the canal, and in some places, banks several feet high were built up. Spoil banks made by the old dredge are now being removed by power shovel and bulldozer to provide a road along the canal. The road will facilitate patrolling and operation of a dragline which has been found more efficient in cleaning and which can deliver muck to a point whence rehandling is unnecessary.

The growth of weeds and willows along the banks as well as subaqueous growths that restrict capacity and retain sediment requires constant attention. These growths are removed, usually at 2-yr. intervals, by men working from a specially designed pontoon barge made up with sections of 24-in. pipe, 16 ft. long, bulkheaded at each end and equipped with an automobile engine driving a propeller. Three of these barges are in use.

At first a power-driven pump on the barge was used to spray a distillate-type oil on the growths above water level. This plan was aband-

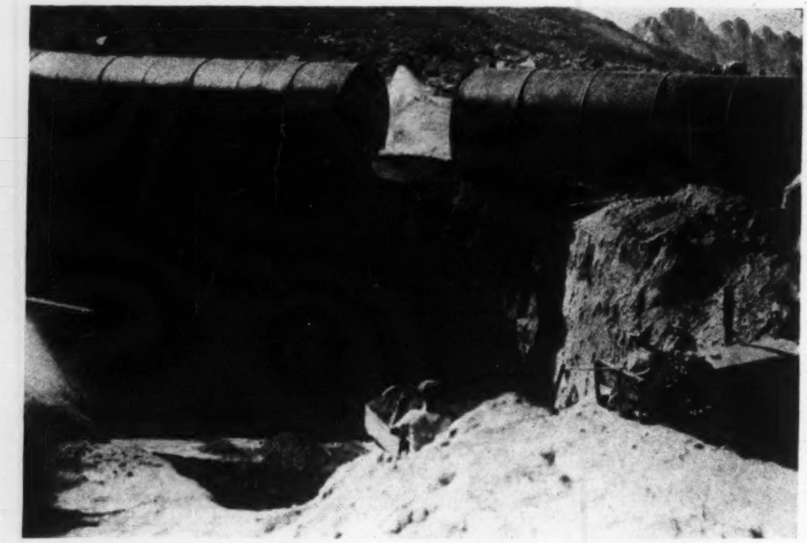


Fig. 3. Making a hydraulic fill to replace supports washed out when the Grapevine siphon was dynamited by saboteurs in 1931.

oned when it was found to kill the roots which perform a valuable function in retaining bank slopes. Now the bank growth is allowed to reach a certain height and is periodically cut off and burned at the top of the slope.

Eel grass on the bottom of the canal was at first treated with copper sulphate without much success. The method now used is to cut it with a 15-ft. bar having a sharpened forward edge. Towed behind the barge this bar removes the grass without damaging the bottom.

Although open canals are located chiefly in fairly impervious earth, there are short sections porous enough to permit seepage through the bottom and sides after each cleaning period when the seal of silt has been disturbed. To prevent excessive losses during such periods, bentonite usually is employed to seal the canal immediately following cleaning or upon discovery of large seepage losses. This emergency seal is increased, of course, by natural deposition.

Occasionally ice jams occur in the open canals and have to be shattered with powder. Years ago dynamite was several times used by saboteurs in attempts to destroy headgates and siphons. Thus repairing dynamite damage became an item in necessary maintenance.

In concrete-lined canals, in addition to the sediment problems already mentioned, wear and damage to the concrete lining must be prevented or repaired. Frost and ice along the waterline are principal causes of this type of damage, although abrasion, back pressures and earth movements often cause breakage.

The original concrete lining is 6 in. thick. Where the lining has been eroded or actually broken away, concrete patches ordinarily are put on by hand. Lesser erosion is repaired by periodic shotcrete treatment put on to thicken and smooth up the lining after holes have been patched by hand. Ideal thickness for these surface treatments with shotcrete has been found to be ½ to ¾ in. No greater durability is reported where thicker layers have been used.

Algae or vegetable growth on the concrete lining has not been successfully stopped with copper sulphate. A more effective treatment has been simply to allow the canal to remain dry for three or four days during which the growths die and break loose. Later the current carries them down to the reservoirs where they are taken ashore and burned. It is notable that where new lining is put in, even where it is troweled to a smooth surface, the first year of immersion will develop upon it a heavier algae growth than forms on old, rough concrete.

Tunnel maintenance

Every foot of tunnel interior is inspected twice a year, usually during the customary spring and fall shutdowns. And these inspections get very careful attention because repairs in tunnels are more difficult, more hazardous and more costly than in canals or conduit. In addition to the erosion and breakage of concrete lining that can occur in open, lined sections, in tunnels ground pressure may develop. Earth shifting that cracks lining is not unknown and gas problems peculiar to tunnels have been met. Only experienced, seasoned employees who know what to look for are entrusted with tunnel patrols.

The first inspection, at each unwatering, is made by two or more patrolmen who walk through their tunnels, alert for new indications of movement and deterioration. The log of the previous visit is a guide to spots whose condition must be compared to that noted before. On all serious indications, the report of this first patrol brings prompt attention from higher authority.

Where the tunnel traverses loose formations, much more attention is given to cracks than in deep, hard formations. The tunnel patrolmen's notes are referenced to station marks painted on the crown above high water level. The high water mark itself is observed carefully for indications of settlement or diminution of carrying capacity due to increased friction from various causes.

Moving ground is a major cause of tunnel repairs. Sometimes it is swelling ground, perhaps caused by leakage through cracks in the concrete lining; again, slides may affect the lining if the tunnel is near the hillside, or deep tunnels may be affected by geological movements. Some causes are just sufficient to crack the lining without any serious consequences. Others crush the lining enough to require replacement and in a few cases collapse of the lining has been complete enough to require a bypass or detour tunnel.

When lining cracks are seen to be serious, immediate repair is made. The usual procedure is to take out the lining in a peripheral ring 1½ to 2 ft. wide and then the cut behind the lining is carried to a depth of about 18 in. These annular rings are made about 6 ft. apart for a 100 or 200-ft. length of the tunnel according to the seriousness of the break. Into the rings thus excavated, curved I-beams are set and bolted up. The beam section is dependent upon conditions and ranges from 10 to 20 lb. per foot. When the steel rings are in place, concrete is filled in around them to restore the continuity of the inside lining surface. These steel and concrete ribs are always put in first, even where it is apparent that the intermediate lining must all come out. The ribs hold and safeguard the tunnel while the intermediate work is done.

An unusual case of gas attack on the tunnel lining in the Soda Hill area, presenting an interesting problem in draining off a gas heavier than air, was described in *Engineering News-Record*, June 23, 1938, p. 885.

Steel pressure pipe

Steel siphons present more maintenance problems than do any of the other types of construction. Chemicals in the water may attack the steel surfaces, the constant "breathing" of long siphons fatigues thin plates near the upper ends, causing crystallization and eventual breaking, or coarse sediment moved along by the water may wear holes in the bottom of the pipe. Unlike other parts of the aqueduct, these steel siphons just do not "stay put;" in addition to the breathing, the temperature changes are factors and sometimes a portion of a siphon will draw right up off its concrete piers. It is largely because of emergencies in the steel siphons that the maintenance department keeps portable welding outfits "on call" 24 hr. per day the year round.

Troubles resultant from breathing have been the most persistent. In fact, after attempting for years to solve this problem, decision recently was reached to replace all $\frac{1}{4}$ and $\frac{5}{16}$-in. plates with $\frac{3}{8}$-in. metal. This work, whose total cost is estimated at about $1,000,000, has now been begun. The stiffness of the $\frac{3}{8}$-in. plate is such that it is not subject to the constant flexing that called the repair crews so often to the lighter metal. In other words, this solution of the problem indicates that no effective means of stopping the breathing in the thinner metal was ever found.

Among the methods tried to cure this ailment were:

(1) An 18-in. vent pipe leading out of the crown of the siphon arch and carried up to a level above hydraulic grade. This failed to carry off entrapped air probably because of the velocity of flow and the great difference in pipe diameters.

(2) Steel channels of 12-in. section, bent to the radius of the siphon pipe, welded on outside as round-about stiffeners. These failed to hold. When the siphon was emptied the plates pulled away from the bands and the pipe flattened as before.

(3) An earth cover or backfill placed around those portions of siphons where plates are thin helped by decreasing the amplitude of the breathing but did not cure it.

(4) Smoothing up the intake curves helped somewhat by decreasing the amount of air entrapped and hence decreasing the cause of water hammer. This improvement could not be carried to a point that would completely cure the trouble.

(5) A mechanical device designed to compensate for pressure pulsations by an automatic valve at the low point in the siphon was carefully considered but was not adopted because of risks that might arise in case of derangement.

Since the removal of gas from Soda Hill tunnel, the acid content of the water has been so low that chemical attack on the interior of steel siphon surfaces has greatly decreased. Prior to that time, however, it was necessary at regular intervals to renew a protective coating on inner surfaces of the siphons. Heat in the emptied pipes, exposed to desert sun, the difficulty of getting ventilation and the dangers of working in darkness on steep, smooth slopes made this painting hazardous and difficult.

Other siphon troubles

Another disadvantage of thin plates is the tendency of such pipe to flatten when the line is emptied. Even with adequate air vents and gradual unwatering, the vertical diameter in thin-plate sections of 10-ft. pipe sometimes decreases as much as 15 in. when the line is drained. An attempt was made to prevent this flattening by using 8x8-in. timbers set in pairs on opposite sides of the pipe, at 12-ft. intervals. Tops and bottoms of each pair were tied together by steel rods above and below the 10-ft. pipe. When the pipe was unwatered, the 8x8-in. posts promptly broke under the horizontal thrust.

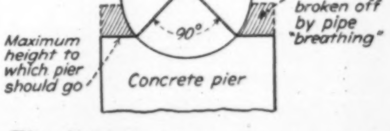

Steel pipe
90°
Concrete broken off by pipe "breathing"
Maximum height to which pier should go
Concrete pier

Fig. 4. The 90-deg. angle is critical value in determining safe height of a concrete cradle around steel pipe.

After emptying a siphon, with resultant partial collapse of the pipe as noted, refilling will restore the diameter almost to a true circle. However, round-about seams usually are so strained by this flexing that they leak badly after the pipe is again filled. These leaks are repaired by caulking and welding with the pipes in service. This welding is not done directly at the point where water is escaping; rather, the leaks are plugged as well as possible with soft wood and then a metal patch is placed over the spot and watertight welds are made around the edges of this metal patch.

On some siphons, water velocity carries a certain amount of gravel through the low point and up the downstream leg to a level where the force exerted by the water velocity is just equal to the down-grade pull resultant from gravity. Here gravel is held, constantly sliding backward and forward on the bottom of the pipe. In time this makes another job for the emergency welding outfit and a "halfsole" has to be put on where the wear has occurred—usually an awkward place to work. A $\frac{3}{8}$-in. "halfsole" or repair plate is used and because of difficulties in working under the pipe, it is usually made to extend around a sector of one-third the pipe circumference.

The concrete piers as originally built to support steel siphons were given too much cradle; that is, were carried too far around the periphery of the pipe. Thus when the pipe tends to flatten due to "breathing" and in the even greater flexures occurring when the siphon is emptied, the steel is bent around the top of the piers. Repeated bending weakens the steel and in many cases has sheared off the top portion of the concrete. It has been observed that where these breaks in the concrete occur, they are almost invariably at the level marking the limits of a 90-deg. subtended angle (Fig. 4). That is, one-fourth the circumference of the pipe can be safely employed as a concrete cradle; any concrete above that level is likely to be sheared off. As a result, in recent years the tops of the original piers have been reconstructed to conform to this 90-deg. limitation and the rule is also applied to new piers.

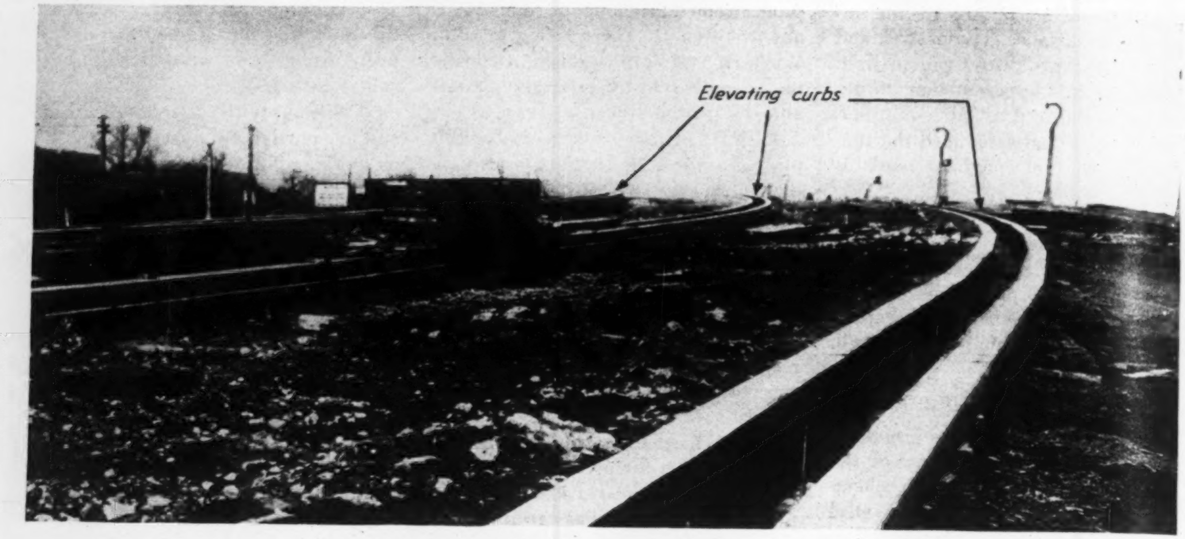


FIG. I. LONG LINES OF SLOTS IN PLACE FOR ELEVATING CURBS ON LINCOLN PARK EXPRESS ROAD IN CHICAGO.

Chicago Builds a Convertible Roadway

Otto K. Jelinek
Traffic Engineer, Chicago Park District, Chicago, Ill.

***Contents in Brief**—New eight-lane access road to the Chicago business district provides traffic with six in and two out lanes, or two in and six out lanes or four lanes each way. This feature is provided by roadway-dividing curbs that can be elevated or retracted by a hydraulic-power system which is electrically actuated. Under-pavement slots for the elevating curbs and a 150-ft. pavement width require special inlet, manhole and pipe system for the practically level road-surface drainage. Automaticity of curb-elevating and retracting operations is made possible by an ingenious control system. Three parallel elevating curbs aggregating over 6½ miles are being installed.*

ELEVATING CURBS are being introduced in Chicago to segregate two-way traffic the heavier current of which reverses direction daily. The curbs are first being installed on 2.2 miles of the new north and south through road in Lincoln Park. About 40 per cent of all the traffic that enters and leaves the Chicago business district uses this route. In the evening over three-fourths of the traffic is moving north and less than one-fourth is moving south; in the morning the volume direction is directly reversed. A study indicated that an eight-lane road would carry the traffic, six lanes for the heavy-volume flow and two lanes for the light-volume flow, if the division by curbs into two and six lanes could be shifted from side to side as the volume of traffic flow shifted. The elevating curbs described here provide this convertibility.

The new road is part of a work, now nearly completed, of modernizing areas and roads in Chicago's famous north-shore park. The many drives that formerly subdivided the park into areas of no recreational value are being reduced in number. The striking elements of this alteration are a north and south through-traffic road and a local-traffic belt road, the plan and construction of the two being such as will discourage mingling of traffic. In general the through road, which is the one of immediate interest, follows the line of the present beach drive and is fairly straight, having no curve of less than 4,000-ft. radius. Some details of the road structure are given later.

The traffic problem

As stated, design was a problem of segregating unbalanced two-way traffic. The accompanying table shows a comparison in the direction of travel for the various important periods of the day, and the volume of the movement as a per cent of the 24-hr. total traffic. These records indicated that six lanes would carry the heaviest rush-period traffic flows, whether south in the morning or north in the evening, and that two lanes would carry the counter-traffic flow of either north or south. Also it was indicated that four lanes each way would meet all non-rush-hour traffic demands.

Assuming that physical separation of opposing streams of traffic was essential, two design possibilities existed: (1) a divided highway each half of which would carry the heaviest rush-hour travel or (2) some form of highway that could be converted

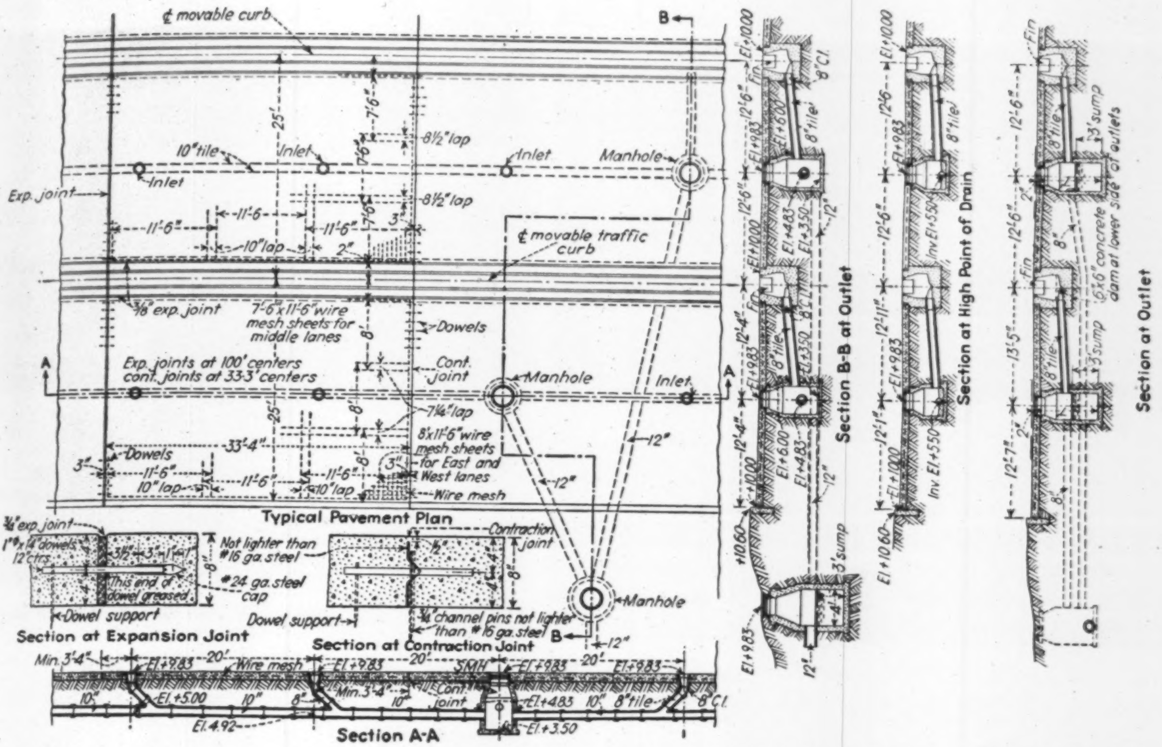

℄ movable curb
B
10" tile
Inlet
Inlet
Inlet
Manhole
Exp. joint
25'
7'-6"
8½" lap
8½" lap
11'-6"
11'-6
11'-6"
10" lap
2"
3"
℄ movable traffic curb
⅜" exp. joint
7'-6"x11'-6" wire mesh sheets for middle lanes
Dowels
Exp. joints at 100' centers
cont. joints at 33.3' centers
Cont. joint
Manhole
Inlet
A
A
7¼" lap
8'x11'-6" wire mesh sheets for East and West lanes
Wire mesh
33'-4"
10" lap
12"
Typical Pavement Plan
¾" exp. joint
1"φ x 14" dowels 12" ctrs.
This end of dowel greased
Not lighter than #16 ga. steel
#24 ga. steel cap
Dowel support
Section at Expansion Joint
Contraction joint
Dowel support
¼" channel pins not lighter than #16 ga. steel
Section at Contraction Joint
Manhole
Min. 3'-4"
El+9.83
20'
Wire mesh
SMH
El+4.83
El+5.00
El 4.92
Cont. joint
8" tile
8" C.I.
El+3.50
Section A-A
Section B-B at Outlet
Section at High Point of Drain
Section at Outlet
Fin
8" tile
3' sump
6"x6" concrete dam at lower side of outlets
El+10.00
El+10.60
Inv. El+5.50

Fig. 2. **Eight-lane pavement on Lincoln Park through road presents an interesting solution of an unusual surface drainage problem due to level cross-profile, great width and the introduction of under-pavement slots for elevating curbs.**

by movable separating strips into roadways of two and six or four and four lanes in either direction. The second possibility was selected for consideration.

In the table it will be noted that the six hours of the rush periods contributed 40.8 per cent of the total 24-hr. traffic. Of this traffic 32.3 per cent operates in the prevailing rush direction and 8.5 per cent operates in the counter-rush direction. With a normal fixed separating strip six lanes in each direction would have been necessary to provide capacity or a combined travel width of twelve lanes. These lanes would have required 148.33 ft. of pavement and 21.66 ft. of center parkway or a total of 170 ft. The 21.66 ft. of parkway is necessary to give scale and proper landscape character to 148.33 ft. of pavement traversing a park. In contrast, with movable separating strips, eight lanes (100 ft.) were adequate and offered a possible saving. It is proper here to state that in the Lincoln Park operation the cost of 70 ft. extra width offset the cost of the elevating curbs to be described more than two to one.

The problem was the movable separating strips. It was solved by devising, after many tests, an elevating curb—a curb 19 in. wide, that can at will be elevated 8 in. above the pavement or lowered to flush with pavement level. As shown by Fig. 2, there are three lines of curbs, one along the center of the eight-lane roadway and one two lanes away on each side of the center curb. Each line of curb retracts into an under-pavement slot that contains the hydraulic jacks, springs, piping, etc.

As structures included in the roadway, the curbs call for first attention in respect to their effect on roadway construction, particularly on drain-

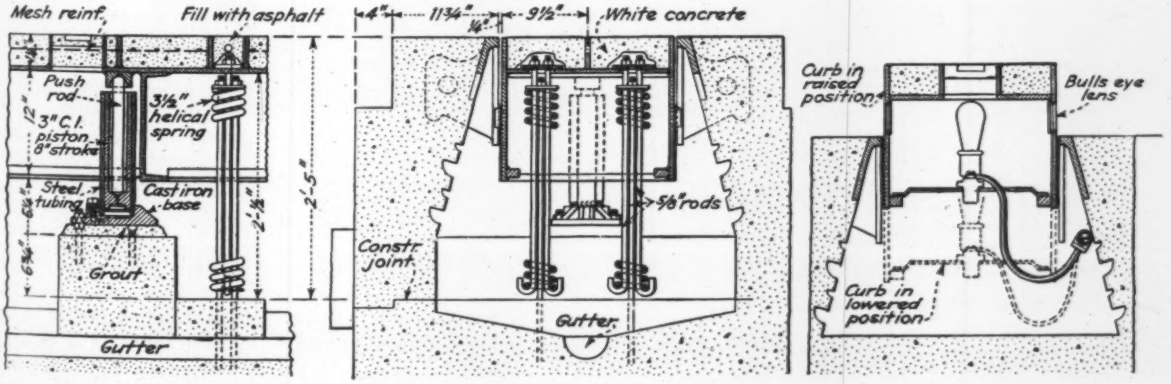

Mesh reinf.
Fill with asphalt
Push rod
3½" helical spring
3" C.I. piston, 8" stroke
12"
Steel tubing
Cast iron base
Grout
2'-5"
2'-1½"
Gutter
4"
11¾"
¼"
9½"
White concrete
⅝" rods
Constr. joint
Gutter
Curb in raised position
Bulls eye lens
Curb in lowered position

Fig. 3. **Sections of curb slot, showing hydraulic jacks and springs for raising and lowering the curb and curb-lighting equipment.**

age, which, as every street-railway engineer will verify, is a vital question where a pavement is under-run by conduits accessible to surface water. The general structural features of the pavement are indicated by Fig. 2. For surface drainage the pavement has four lines of inlets and manholes located between the lines of curbs. From the elevations at curbs and inlets, Fig. 2, it will be seen that each pair of lanes drains to the midwidth line of inlets and manholes for those lanes. The inlets drain longitudinally to the manholes, which also have grated tops to take runoff and the manholes drain to offroad sewers. The curb slots have half-round gutters that are pitched to drain to the manholes. These general details and elevations and dimensions are more fully explained by Fig. 2.

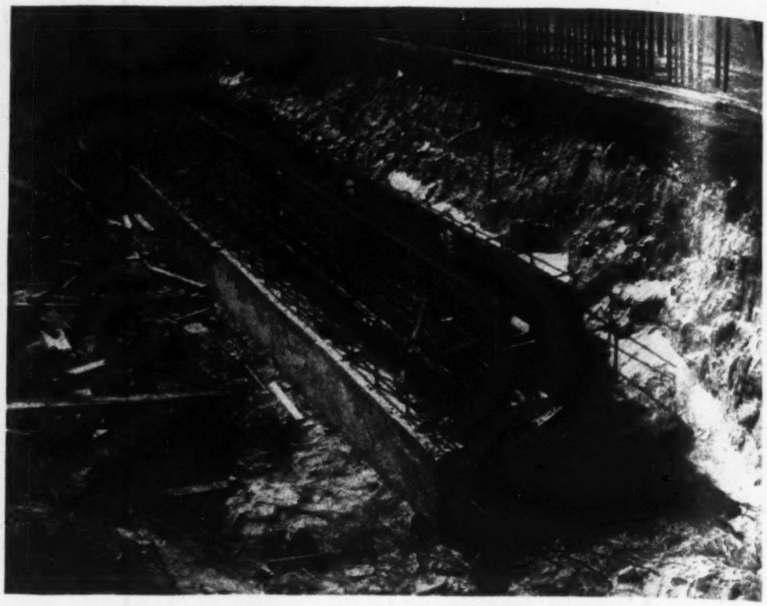


Fig. 5. Setting the steel for a unit of elevating-curb slot on the Lincoln Park through road.

Curbs hydraulically operated

The curbed road, 2.2 miles, is cut into divisions for operation and each division is also cut into two sections. Each division has a separate pump station and distribution system to actuate any one or two or all three lines of curbs in the division. Commonly, at one time, only one curb is operated, and one section at a time and all the curb units in a section simultaneously. Switches at a control station at each end of the road start the train of movements. Considering still a single line of curb, action at the control station starts the first section of curb to lift, all curb units at once; when this section reaches a certain point it automatically starts the second section to lift; in the same way the second section starts the third and so on to the end of the line. The lifting action is a sort of wave action, the speed of the wave being about 20 mph. In lowering, the whole line of curb retracts at the same time and the time is adjustable between 10 and 20 sec.

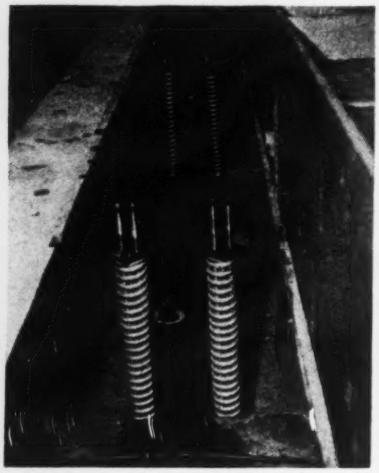


Fig. 4. Looking down into the curb slot before the curb is placed, showing the elevating jacks and the retracting springs for a 25-ft. curb unit.

The curb, shown in several sections by Fig. 3, is made up of 25-ft. lengths of inverted U-section steel plate having a recessed top to hold a slab of white cement concrete. The metal of the curb is bright-finished by an aluminum process and is painted federal yellow on the sides. In the sides at intervals are also lenses which, lighted from behind, delineate the raised curb at night. Each 25-ft. length of curb rests on two hydraulic jacks and six spiral springs as shown by Fig. 3; the jacks and springs are seen exposed in Fig. 4. The curb is lifted above the pavement and *held up* by the jacks; this puts the springs in tension and when the jack pressure is released they pull down the curb flush with the pavement. The lifting power of the jacks is 12 tons and the retracting power of the springs is 10 tons; a strong pull is necessary at times to break down ice or other obstacles and seat the curb flush with the pavement.

Only one line of curb at a time is raised in the normal operation of the road. The location of the up-curb depends on the density and direction of traffic during the various periods of the day. (See Table). In the morning rush hours when the traffic is directional to the business district, the east line of curb is raised thereby separating the roadway into six lanes for southbound traffic and two lanes for northbound traffic. In the evening rush period when the prevailing traffic is directionally away from the business district, the west line of curb is raised, thereby separating the roadway into six lanes for northbound traffic and two lanes for southbound traffic. During the periods between the morning and evening rush hours, which may be termed the normal periods, due to the even balance of flows, the center line of curb is raised to separate the roadway into equal parts. The raising and lowering of the curbs is controlled by switches from the control boxes which are located at the two extremities of the system as described later.

Power and Operation

The power system consists of a pump station, pressure tanks, sump tanks and piping and wiring for each division; the piping and wiring also interconnect the divisions. Pump stations, pressure tanks and sump tanks are located in the slot for the center curb line. The operating sequence is: By a hydraulic fluid and a gas, the pumps build up enough power in the pressure tanks to elevate a line of curb; piping from the pressure tanks applies this power to the lifting jacks; the lifting jacks when retracted drain

NORTH AND SOUTH TRAFFIC VOLUME AT DIFFERENT PERIODS OF THE DAY THAT WILL USE THE LINCOLN PARK THROUGH ROAD, CHICAGO, ILL.

Period	Curb arrangement	Length of period hours	Direction of travel per cent N.	Direction of travel per cent S.	Movement per cent of 24 hr. volumes N.	Movement per cent of 24 hr. volumes S.
Morning rush 6:30-9:30 a.m.	6 lanes So. 2 lanes No.	3 hr.	17.7	82.3	3.2	15.1
Daylight normal 9:30 a.m.-4:00 p.m	4 lanes So. 4 lanes No.	6.5 hr.	46.7	53.3	13.1	15.0
Evening rush 4:00-7:00 p.m.	2 lanes So. 6 lanes No.	3 hr.	76.3	23.7	17.2	5.3

to the sump tanks; the pumps withdraw the hydraulic fluid from the sump tanks and put it again in circulation. The pressure tank pressures vary from 1,800 to 2,400 lb. per sq. in. The system has enough capacity for raising or lowering all three lines of curbs without excessive pressure drop.

Initially to prepare the system for hydraulic action, it is necessary to introduce glycerine into each of the 16-in. spherical pressure tanks. Then "Hycon" fluid is introduced on top of the heavier glycerine in the pressure tanks and also into the 16-in.-diameter sump tanks. When the system is sealed, nitrogen is introduced through charging valves into the pressure tanks.

The pump stations, which measure about 4½ ft. x 2 ft. 2 in. in plan by 2 ft. 4 in. high are mounted on concrete pedestals and house two 1-hp. motors that operate high pressure pumps that are capable of delivering 130 cu. in. of oil per minute at 1,750 rpm. Also located in these stations are the switches, gages and other hydraulic and electrical accessories that are necessary for operation.

Throwing a switch at the control station allows 220-volt a.c. single-phase current to flow to the motors through pressure switches. The motors then operate the pumps which supply oil to the pressure tanks through a relief valve. Should the oil pressure exceed a predetermined amount, a relief valve will by-pass further pumpage to the sump tanks. However, this is not normally possible since the pressure switch, which is set about 100 lb. less than that for the relief valve, will cut out the motors. Once the line switch is thrown in, all operations become automatic and the result is a constant pressure in all of the pressure tanks.

When the traffic control switch is thrown, a solenoid is actuated which allows oil to flow at the established pressure through relief valves to the jacks which raise the units in the first section of the first division of curb and so on as previously described.

When a line of curb is to be lowered, the traffic-control switch is thrown out, allowing the solenoid to fall, which reduces the oil pressure in the jacks to zero. The flexed springs then pull the curb down, forcing the oil back into the sump tanks, where it is fed back into the pump by suction as required.

Credits

The operation described is being carried out by the Chicago Park District Commissioners, R. J. Durham, president, Ralph H. Burke, chief engineer, and James P. Gallagher, principal construction engineer.

Wichert Spans on Potomac Bridge

***Contents in Brief**—For a new $1,000,000 bridge over the Potomac River at Hancock, Md., Wichert pinned rhomboid panels over the intermediate piers have been used for both truss and girder spans. Crossing includes a six-span continuous truss section, two five-span continuous plate girder sections, a four-span continuous plate girder and seven simple I-beam spans.*

An interesting adaptation of the Wichert truss design has recently been incorporated in a new bridge built by the State Roads Commission of Maryland, in cooperation with the West Virginia State Roads Commission, to replace the old interstate bridge over the Potomac River at Hancock, Md. and to provide a grade separation with two nearby railway lines and an intersecting highway. Both the truss and the girder spans in the bridge utilize the Wichert pinned rhomboid panel over the intermediate piers, claimed advantages of which are that stresses do not increase due to pier settlement nor with temperature differences in top and bottom chords, and that, since it makes the structure statically determinate, the stresses can be computed with greater accuracy and rapidity than is possible with the conventional continuous truss. In the case of the Hancock Bridge a substantial saving of metal, a pleasing architectural effect and reduced substructure work are said to have resulted.

Since a new bridge near the old structure would have involved costly rights-of-way, undesirable alignment and a dangerous traffic intersection, the location shown by Fig. 2 was chosen, which provides both good grades and safe sight distances. Starting at the north end, the project consists of the following features:

(1) A four-span Wichert continu-

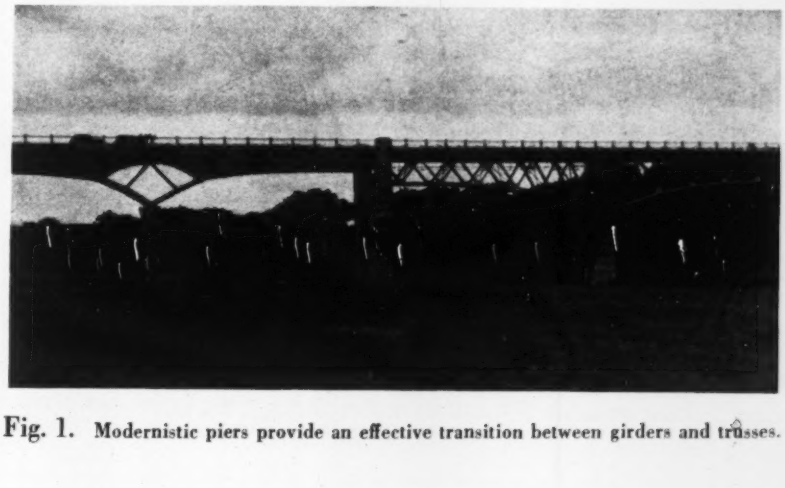


Fig. 1. Modernistic piers provide an effective transition between girders and trusses.

ous plate girder spanning Tonoloway Creek and Route 40, the end spans being 130 ft. and interior spans 160 ft.;

(2) An earthfill section 388 ft. long;

(3) A section spanning the Western Maryland Ry. and the C&O canal, consisting of seven simple I-beam spans totaling 308 ft. and a five-span Wichert continuous plate girder unit having 100-ft. end spans and 140-ft. interior spans;

(4) A six-span Wichert continuous truss section over the Potomac River —end spans here being 117 ft. 9 in. and interior spans 196 ft. 3 in.; and

(5) An approach on the West Virginia side consisting of a five-span Wichert continuous plate girder with 100-ft. end spans and 140-ft. interior spans passing over the Baltimore & Ohio R. R. tracks.

The plate girder spans over Route 40 and Tonoloway Creek have a center depth of 6 ft. 6 in., which increases to 20 ft. over the piers while the plate girder spans joining the South end of the I-beam section over the Western Maryland Ry. to the main river bridge have the same depth over the piers but are only 5 ft. 6 in. deep at the center. The main river truss spans, with curved bottom chords, have a depth at the center of 11 ft. and at the piers of 30 ft. 6 in. The West Virginia approach is similar to the plate-girder construction at the north end of the river crossing.

The truss spans are carried on solid reinforced concrete piers with semicircular ends, while for the girder span piers two circular shafts connected by a web wall are used. One of the modernistic piers, providing an effective transition between girder and truss spans, is shown in Fig. 1. Abutments are of the open bent type with massive pilaster posts.

In constructing the foundations all concrete was pumped from the mixer to hoppers located on top of the substructure units from which it was transferred to the forms through elephant trunk chutes equipped with baffle plates to prevent segregation. All concrete was placed with the aid of internal vibration and was water-cured. Due to the use of plywood forms, no rubbing was necessary.

Superstructure work was begun on the West Virginia approach with locomotive cranes on the Baltimore & Ohio Ry. erecting in one piece the girders to span the tracks. Temporary bents were required at each pier until the rhomboid members could be erected. A traveler crane was then placed on the completed span for erection of the remaining girder spans of this approach and the truss spans of the river crossing. These girders were also erected in one piece but the truss spans were placed in three pieces, an intermediate falsework bent being required for each span.

The I-beam and girder spans at the Maryland end of the main crossing were erected simultaneously with the truss spans and in much the same way as the girders of the West Virginia approach. However the end girders for the crossing over Tonoloway Creek were erected in two pieces and those for the center spans in three pieces, this work being done in much the same way as erection of the truss spans.

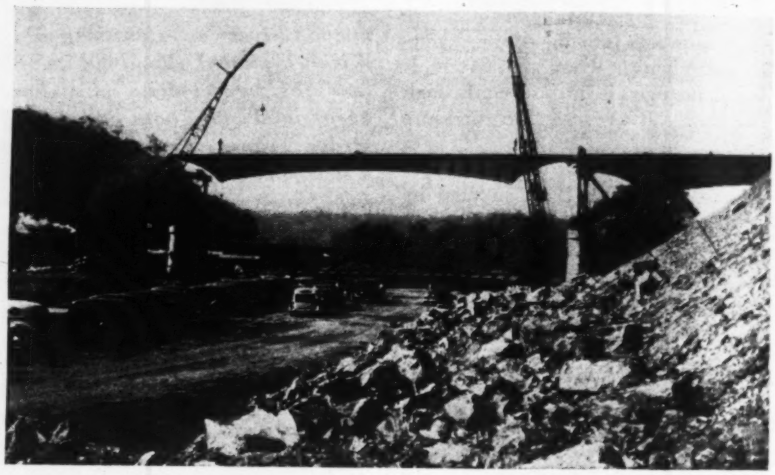


Fig. 3. Erection of the rhomboid panels required temporary bents over the piers.

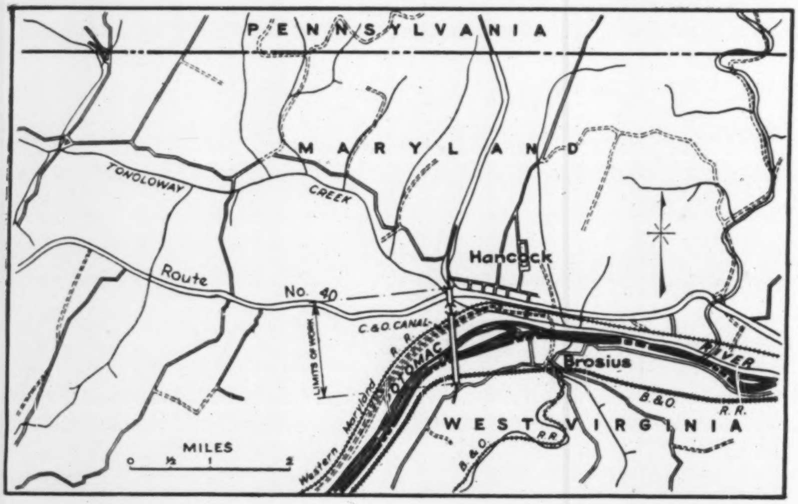


Fig. 2. Good alignment is provided, costly rights-of-way avoided, and dangerous traffic intersections eliminated with the location shown.

The project was completed at a cost of about $1,000,000, one-half the cost having been met by federal grant and the remaining cost shared equally by West Virginia and Maryland. Bridge Engineer W. C. Hopkins, under the direction of Chief Engineer Nathan L. Smith, was in charge of design and supervision for the Maryland State Roads Commission. C. Steuart Linville was resident engineer, and L. T. Downey, district engineer. Geo. B. Hazelwood, Cumberland, Md., the general contractor, was represented on the job by W. C. George. All structural steel was fabricated and erected by the Bethlehem Steel Co., with C. W. Leatherman in charge.

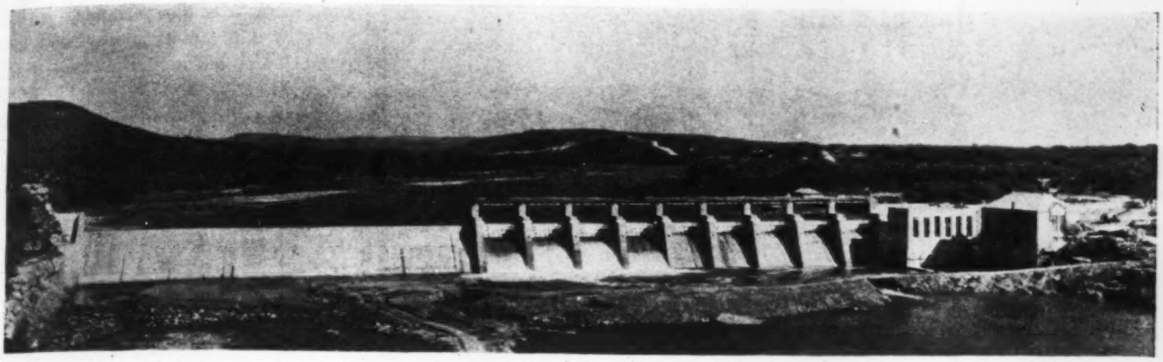


FIG. 1. RECENTLY RECONSTRUCTED AUSTIN DAM, OF NOTEWORTHY RECORD, FOR FLOOD CONTROL OF THE COLORADO RIVER.

Grouped Reservoirs Control Floods

CLARENCE McDONOUGH
General Manager, Lower Colorado River Authority, Austin, Tex.

***Contents in Brief**—Floods that annually have damaged city property and downstream agricultural lands are being placed under control by four dams on the Colorado River above Austin, Tex. With a flood storage capacity of about 3,000,000 acre-feet these dams also provide 147,000 kva electric power, which, with the sale of irrigation water, will amortize the cost of $48,000,000.*

THE COLORADO RIVER in Texas for about 300 miles to its mouth has long presented a major flood hazard. For years the flood damage in the river valley has averaged $3,370,000 a year. To check this loss the Lower Colorado River Authority since 1931 has been constructing a series of dams and storage reservoirs at a cost of $48,000,000. Three dams have been completed and another, built first to a lower level, is now being increased in height. Hydro-electric plants having a total capacity of 147,000 kva are essential elements of the dam construction.

While complete flood control calls for further work, particularly a levee system downstream from the dams, the operations completed and in progress make up one of the most important of recent river developments. Besides flood control the works provide for amortization of their cost by a sale of electric power and irrigation water. In view of its triple purpose the work of the Lower Colorado River Authority stands out somewhat by itself among river improvements.

The accompanying sketch map helps to indicate the problem faced. As seen, the Colorado River crosses Texas in about its widest part. It is 800 miles long from the New Mexico boundary to the Gulf of Mexico and has a watershed in Texas of 42,000 sq. mi., about the area of the state of Pennsylvania. While rising in the semi-arid plains of southeastern New Mexico and western Texas, the river at Big Spring, Fig. 2, enters a region of torrential rains increasing in severity and frequency downstream. At places, individual stations have shown 30 in. of precipitation in a single day. This rainfall coupled with the steep slopes and shallow soils of the watershed south of San Saba County to Austin, the state capital, produces high flood runoff.

With these conditions the Colorado River at times is a raging flood and again is a slender stream barely producing enough water for the domestic supply of the cities along its banks. In the section of stream being considered, beside the domestic needs there was need of water for 60,000 acres of rice under cultivation and 150,000 additional acres available for cultivation when water is provided. There was also a market for power. The river problem then presented itself as a combined water supply, flood control and power supply undertaking and has been so worked out by the Lower Colorado River Authority. The sale of power and of irrigation water fetches in the money depended on to amortize the cost of construction.

For construction, the Public Works Administration has financed the authority through a loan and grant in the amount of $25,056,000 for the authority's portion of the dams and facilities; the Reconstruction Finance Corporation has advanced loans to the amount of $5,300,000 for the purchase of existing transmission and distribution facilities acquired from the private utilities, and the federal government through the Bureau of Reclamation and other agencies has advanced $17,689,000, making a total of $48,045,000 in cost.

A wide construction program

The authority's program of construction provided for the building of Buchanan, Inks and Marshall Ford dams; the reconstruction of the Austin Dam; and the construction of power plants, substations and transmission and distribution systems to dispose of the power generated.

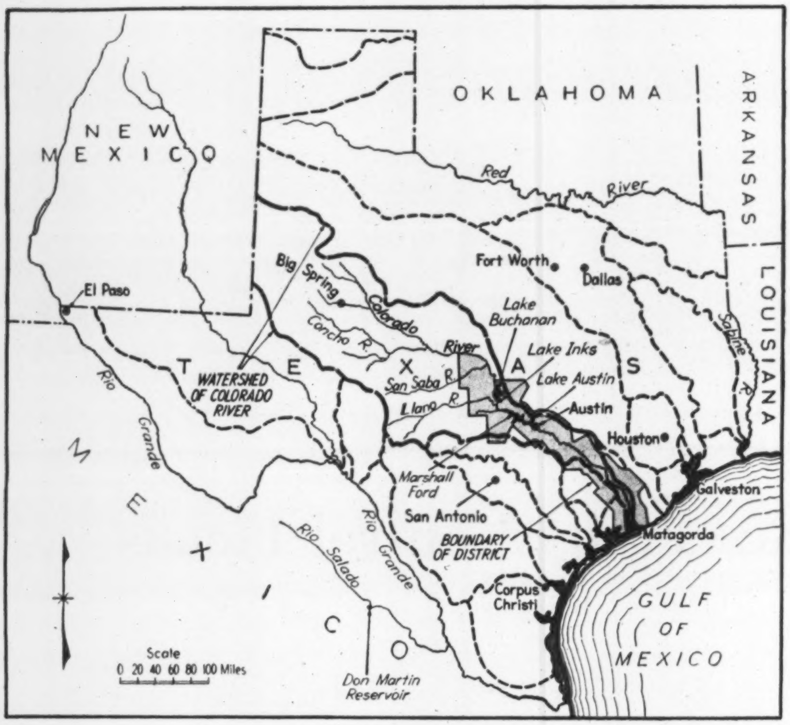

OKLAHOMA
ARKANSAS
NEW MEXICO
LOUISIANA
TEXAS
MEXICO
Red River
Fort Worth
Dallas
El Paso
Big Spring
Colorado River
Concho R.
Lake Buchanan
Lake Inks
Lake Austin
San Saba R.
Llano R.
Austin
Houston
WATERSHED OF COLORADO RIVER
Rio Grande
Marshall Ford
San Antonio
Galveston
Matagorda
BOUNDARY OF DISTRICT
Rio Salado
Corpus Christi
Sabine R.
GULF OF MEXICO
Scale
0 20 40 60 80 100 Miles
Don Martin Reservoir

Fig. 2. **The 42,000-sq. mile drainage basin of the Colorado River in Texas showing the present development district and the four dams built for flood control.**

Studies showed that floods could occur in the lower reaches of the river from precipitation on the flat coastal plain independently of the flow from the upper river, but it was not within the finances of the authority to construct levees at this time. Surveys and plans have been made for this work if, in the future, its construction should become feasible. The main dam structures are:

Buchanan Dam—Early in 1931, construction started on Buchanan Dam (formerly known as Hamilton Dam) near Burnet, Tex., to develop power, but due to financial difficulties, work was discontinued in 1932 with the dam about 20 per cent complete. The authority purchased the property from the receiver in 1935 and re-designed and completed the structure during the succeeding two years. The total length of the dam is 11,000 ft. in two sections of multiple arch construction, gravity sections, spillways, and earth embankment. The maximum height is 155.5 ft. in the deepest part of the multiple arch section. These arches are 70 ft. in span and vary in thickness from $3\frac{1}{3}$ ft. at the bottom to $2\frac{1}{3}$ ft. at the top. The supporting buttresses likewise vary in thickness from 9 ft. at the foundation to 3 ft. at the top. The dam is founded on pink granite and gneiss, with some schist intrusions. Spillways were located at advantageous points along the north part of the dam where economy of construction was obtained and erosion was of less concern.

The discharge gates, all Tainter type, include 7 gates 40x25 ft., and 30 gates 33x15 ft.; in addition, an uncontrolled spillway of 1,100 ft. in length has been provided. The spillway can discharge a total of 585,000 cfs with full pond.

The storage capacity of the reservoir below the uncontrolled spillway elevation is 1,000,000 acre-feet, half of which is above the gate sills of the larger gates and constitutes controlled storage. This makes it pos-

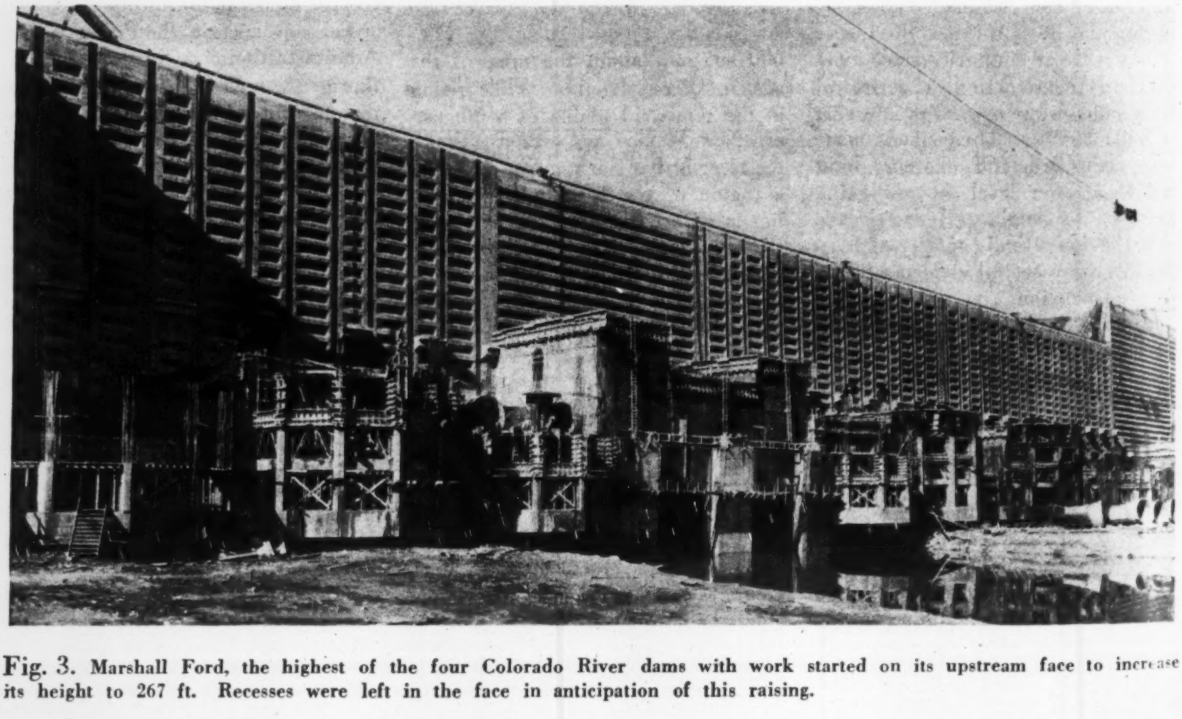


Fig. 3. **Marshall Ford, the highest of the four Colorado River dams with work started on its upstream face to increase its height to 267 ft. Recesses were left in the face in anticipation of this raising.**

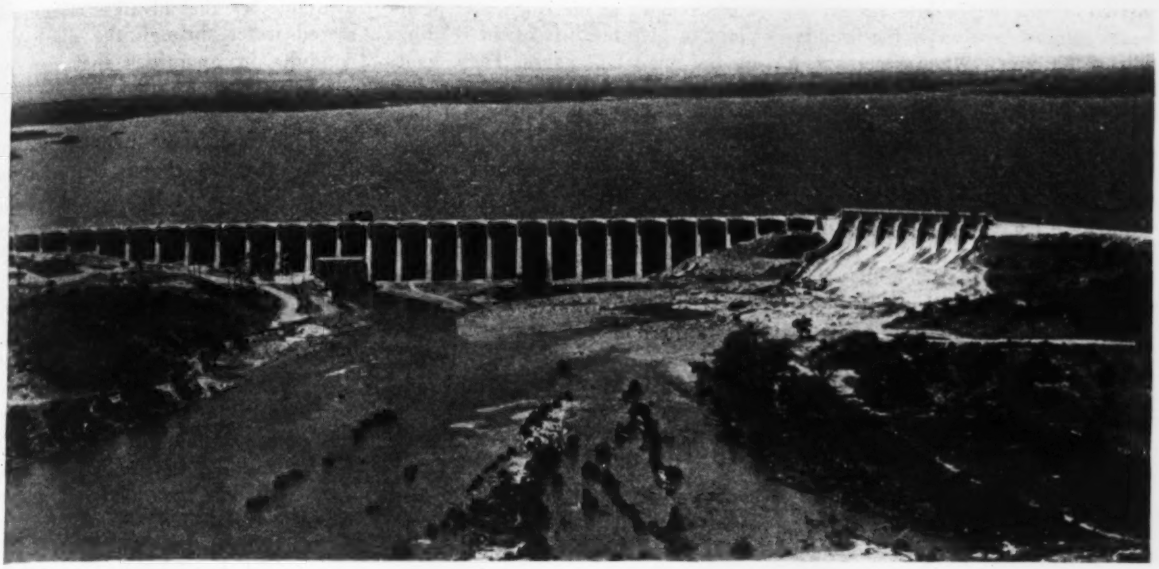


Fig. 4. **Buchanan Dam showing the high multiple arch section and one of three Tainter gate spillways.**

sible to discharge a large portion of the stored water in advance of a flood to provide storage for regulation of the flood flow of the river. The mean regulated flow at the damsite will be 1,200 cfs. A power plant has two 12,500-kva generating units, with provision for the installation of a third unit of equal size at a later date.

Inks Dam—Inks Dam, the smallest of the chain, is 3 miles downstream from the Buchanan Dam. It is intended primarily for power production and will utilize the regulated flow from Buchanan Dam, plus a regulation of water stored for daily peaks in its own reservoir. It has 12,500-kva installed capacity. Transformer stations at Inks and Buchanan are provided for stepping the generated voltage up to 138 kv for transmission over two separate lines to the main substation and distribution point at Marshall Ford.

Marshall Ford Dam—The Marshall Ford Dam is located 25 miles upstream from the city of Austin and below the principal tributaries entering the Colorado River. Upon this mighty structure will depend much of the success of the flood control operations.

The first stage of the development —the low dam—has been completed and the high dam is now under construction. The high dam will be 267 ft. high above its foundations. It is a gravity type in both bulkhead and spillway sections. The uncontrolled spillway is 730 ft. long and is capable of discharging 450,000 cfs. For the control of flood discharges, there are, in addition, 24 102-in.-diameter controlled discharge conduits in the base of the spillway section capable of discharging 110,000 cfs.

The dam is founded on Glen Rose limestone that, although soft, is sound and reasonably free from seams and sufficiently tight for the purpose of founding a dam.

The reservoir, when filled to the crest, has an area of 29,500 acres and a capacity of 1,962,000 acre-feet of water below the crest. In addition, there is surface storage of 448,000 acre-feet usable in times of flood. This volume represents the amount of water that could be stored above the crest level and still limit the spillway discharge to regulated requirements. In storage capacity, this dam ranks seventh with all dams constructed in the United States to date.

Three 25,000-kva generating units will be installed in the power house. The main switching and transformer station is being constructed at this point. All of the four plants will be tied with a double transmission line to this substation. There are four 138-kv transmission lines and three 60-kv lines connecting at this point with transformer and switching facilities to move the power and energy out with sufficient flexibility to meet the requirements of the authority and its customers.

Austin Dam—Austin Dam, located 3 miles west of the center of the city of Austin, is the last in the chain of dams. It has the regulation of flow from the upper dams which made its rebuilding practicable. In view of its unfortunate past, it would appear to be something for engineers to eschew. However, vast experience has been acquired in the construction of dams, together with the development of proper construction tools and equipment, so that the solving of the problem of its construction today is not so difficult as when the dam was first built in 1893. Failure of the first designers to make a thorough investigation of the underlying rock and to take the necessary steps to correct the existing conditions contributed to the first failure. Another reason for its failure was the lack of any records of river discharge upon which to base a proper figure as to the probable expected discharge for use in designing a suitable spillway section.

The dam was rebuilt in 1915 without a proper investigation of underlying foundation conditions and with no serious attempt to correct them or give proper consideration to the floating drift that would have to be discharged during times of high water. The geological and hydrologic conditions prevailing at the site have been exhaustively studied and the present dam has been built to meet the requirements.

It has an uncontrolled spillway 442 ft. long, four Tainter gates 51x18 ft, and five Tainter gates 51x12 ft., with hinges located at a safe height above the water crest when discharging 550,000 cfs.

Adequate section was provided for stability, and a concrete apron was carried 45 ft. below the bucket to insure against erosion of the foundation of the dam. When necessary, a grout curtain was carried to a maximum depth of 100 ft. below the foundation and, in some cases, required holes spaced on 1-ft. centers. The dam foundations in the maximum cases were carried to a depth of 95 ft. below the crest.

The regulated flow of the river will be 2,000 cfs and the pondage at the dam will be sufficient for daily regulation.

The authority has installed 15,000 kva of generating capacity of movable blade units operating under a head of 61 ft.

Advance storm information

For the best control of floodwater by these dams, prompt information of rainfall is necessary. It has been found that a 2-in. rainfall is evaporated and absorbed with no increase in flow into the reservoirs. The authority has 134 rain gages strategically placed both in the contributory territory and on the borders of the drainage area, with observers in telephonic communication with the main office. These observers report by telephone any rainfall of 2 in. or more during a 24-hr. period and also keep a daily record which they mail monthly to the authority for its information. Upon notice by 'phone of a 2-in. or better rainfall, the authority calls other parties adjacent to the one reporting until the extent of the rainfall area is defined. If this should be sufficient to necessitate release of water, the authority has from three to five days expectancy before the water reaches its Buchanan Dam if the rainfall has been on the headwaters of the river, and three to four days if it has been on the area directly tributary to the Marshall Ford reservoir.

Twelve river gages are located in the tributaries and the main river which are operated jointly by the United States Geological Survey, the State Board of Water Engineers, and the authority. Constant reading of these gages gives further information on the probable flow into the reservoirs two to three days in advance and allows more accurate operation of the gates to control the discharge. Seven of these gages will be equipped with short-wave radio automatic broadcasting units which will record every hour on a ticker tape receiver at the Buchanan power plant to give more frequent readings on the important gages. These gages will start broadcasting when the gage registers a minimum for flood flow.

With this advance information of three to five days before the flood flow arrives at the reservoir, plus a continuous knowledge of the rate of flood discharge, it is calculated that sufficient time allowance will be provided, as well as sufficiently accurate determination of discharge, to operate the gates on the Buchanan and Marshall Ford dams effectively to check flood discharges.

Flood capacity of dams

Buchanan Dam has 300,000 acre-feet of storage that can be released within time limitations, through the discharge gates, to provide for additional flood storage. During normal operations in the production of power and release for irrigation, at the time of any past floods, there would have been available 300,000 acre-feet of empty storage capacity in this reservoir.

Marshall Ford reservoir, upon which depends much of the ability to control floods, has a capacity devoted entirely to flood storage of 804,000 acre-feet, and super-storage of 448,000 acre-feet above the crest. Additional storage will be made available by the advance release of stored water through the discharge conduits in quantities that can be safely carried by the river, which release, over a period of three days, would provide for 540,000 acre-feet. During the time that is required for filling the reservoir, an additional 540,000 acre-feet can be passed through the discharge conduits, making a total of 2,332,000 acre-feet of flood discharge that can be handled by this reservoir even if no drawdown for power has occurred previous to the last filling of the reservoir. If normal drawdown for power has occurred since the last filling of Buchanan and Marshall reservoirs, 3,000,000 acre-feet of flood waters could be controlled.

The maximum flood of record occurred in 1938 and had a total discharge of 2,000,000 acre-feet, with a discharge of flood proportions over a period of seven days. By calculations based on the best available data, a flood of 2,380,000 acre-feet could be expected once in a 100-year interval and a flood of 3,320,000 acre-feet could be expected once in a 500-year interval. Marshall Ford Reservoir should be capable of regulating all floods that have been recorded or that might be expected within the range of years that it is expected to be in service.

Flow of Sludge in Pipes

For calculating the flow of sludges of various kinds in pipes, by gravity or pumping, there is as yet inadequate information as to the head losses due to friction. In the pumping of sewage sludge it has been assumed that the common hydraulic formulas for flow of water may be used, provided that the velocity is sufficient to insure turbulent flow. But investigations at the University of Illinois, indicate that this method is only an approximation of the true conditions.

This investigation is covered in a report on *Laminar Flow of Sludges in Pipes*, by Harold E. Babbitt and David H. Caldwell, in *Bulletin* 319 of the engineering experiment station. It is pointed out that the only methods available for determining friction losses for plastic materials in pipes have been empirical formulas and reports of a few special instances. The study has a bearing on such materials as sewage sludge, sludge from water purification plants, wood pulp, dredged clay and sand, and the mud used in oil-well drilling. Viscosity and plasticity are important factors, and it is considered evident that sewage sludge and clay slurries are true plastics.

Conclusions presented are, in brief, as follows: (1) Sludges such as mixtures of clay and water used in deep-well boring, sewage sludges, sludges from water-softening plants, and other similar aqueous suspensions of fine particles, obey the fundamental formula for the flow of a true plastic; (2) for sludge flowing in a pipe a critical velocity is encountered as the velocity of flow is increased—below the critical point the flow is laminar, while above it the flow is turbulent: (3) further research as to the factors affecting turbulent flow in pipes is desirable, as the common hydraulic formulas for flow of water are not applicable to the flow of sludge.

Delaware Aqueduct—IV

Access to the Aqueduct

***Contents in Brief**—This fourth article of a series on the Delaware water supply project describes the manner in which connections to the tunnel will be made at intermediate points along the 85-mile route. These "taps" to the deep tunnel—which provide a means for drawing off water—are made through shafts which are equipped with valves, pumps and access facilities. Previous articles in the series appeared April 11, p. 513; April 25, p. 584; and May 9, p. 656.*

RISER AND DRAINAGE SHAFTS with their valves and pumping appurtenances called for special consideration in the design of the Delaware Aqueduct. The riser shafts, of which there are nine, provide a means for drawing off water at intermediate points along the 85-mile tunnel for the supply of other communities. The drainage shafts, of which there are three, facilitate prompt unwatering of the tunnel, and afford a means of convenient access.

Typical details of the riser shafts and the underground valve chambers at their tops are shown in Fig. 2. Each riser terminates at its top in a bronze cross or shaft cap securely anchored not only to the steel riser pipe but also by means of long anchor bolts into the concrete shaft masonry. Each outlet from the shaft cap is closed by a bronze guard valve. When the time comes to make connections for supplying water to neighboring communities, or to the Catskill Aqueduct at Shaft 4, (see map, *ENR*, Apr. 25, 1940, p. 587) or for pumping from adjacent reservoirs of the Croton system at Shafts 11 and 13, iron or steel valves will be placed beyond the bronze valves for ordinary operation. The bronze valves will then be used only to make shutoffs when the steel valves are undergoing repair. The shaft cap and all valves, meters, and operating equipment at the shafthead will be enclosed and protected by a massive reinforced-concrete underground valve chamber. Shaft caps and valves are designed, according to location, for water pressures of 200 to 325 lb. per sq. in. including water hammer.

At such depth in each riser pipe as to be secure against any possible damage, and not less than 150 ft. deep in sound rock, there will be a bronze needle valve. This riser valve is so controlled by apparatus in the underground valve chamber that it will rise against its seat and close automatically:

(1) if the underground valve chamber is flooded by breakage of pipes, or
(2) if the velocity of water in the riser exceeds that for which the tripping mechanism is set, as would happen in case of a wide open break in one of the outgoing trunk mains, or
(3) if the tripping mechanism is released manually, which can be done by fingertip control.

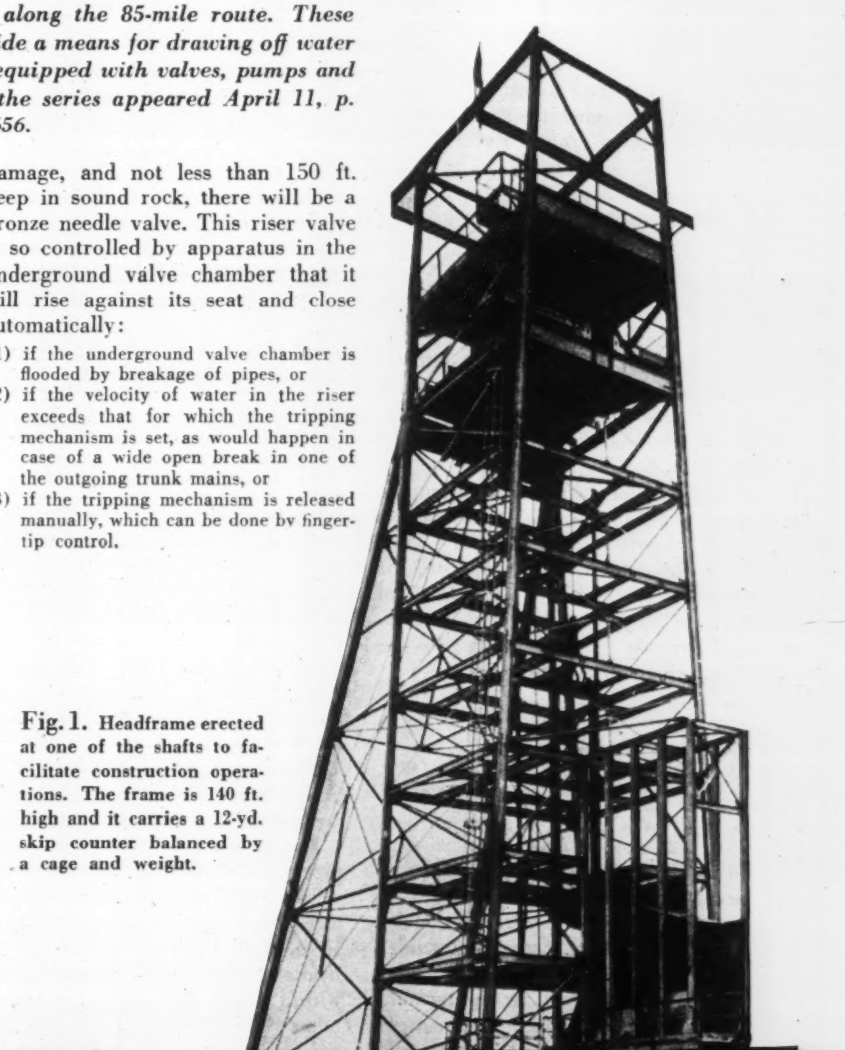


Fig. 1. **Headframe erected at one of the shafts to facilitate construction operations. The frame is 140 ft. high and it carries a 12-yd. skip counter balanced by a cage and weight.**

The rate of closing will be automatically regulated, the valve moving rapidly during the greater part of its stroke and slowing down as it approaches its seat. This procedure accomplishes both a quick closure and keeps the water hammer pressure low whatever the initial velocity may be through the valve. These riser valves are similar to those which have been installed in all the risers of the previously built city tunnels No. 1 and 2.

Drainage shafts

Three drainage shafts will serve, respectively, the 45-mile Rondout-West Branch tunnel, the 22-mile West Branch-Kensico, and the 14-mile Kensico-Hill View tunnel. The functions of these shafts are:

To make possible the prompt unwatering of the tunnel whenever necessary for inspection and repair; and
To afford facilities for safe and convenient access to the tunnel after such unwatering.

The quantities of water to be removed are so large and the depths so great that it has not been considered permissible in the case of any of the pressure tunnels built by the Board of Water Supply to rely upon improvising pumping equipment when the need should arise, with the consequent uncertainties and delays. For these three tunnels the quantities of water to be pumped out (provided there is no inward leakage) and the approximate static heads to be pumped against, are as follows:

Shaft No.	Name of tunnel	Approximate quantity	Approximate static lift
6	Rondout–West Branch....	232 mg	680
13	West Branch–Kensico.....	174 "	350
23	Kensico–Hill View........	164 "	320

It was not considered permissible to rely upon improvised means of access after the tunnels should be unwatered, hence the drainage shafts are equipped with permanent guides, cages and hoists. The only other means of access will be the terminal waterway shafts in each case, supplemented by Shaft 2A, 1,550 ft. deep, and Shaft 8, 949 ft. deep in the Rondout-West Branch tunnel, and the two shafts at Eastview filter site (Shafts 19) in the case of the Kensico-Hill View tunnel. In order to use these shafts, improvised hoisting equipment will be employed.

While supplying water to adjacent communities is not a primary function, each drainage shaft will also contain one or two steel riser pipes lined with concrete to 48 in. inside diameter. Riser valves deep in sound rock and control equipment at the top, similar to that previously described at shafts 4, 5A, 11, 20, 21 and 22 will be installed. Shafts 6 and 13 will each contain one such 48-in. riser, and Shaft 23 will contain two. The riser at Shaft 13 will also serve for pumping into the tunnel from the nearby Cross River reservoir of the Croton system whenever this may be desirable.

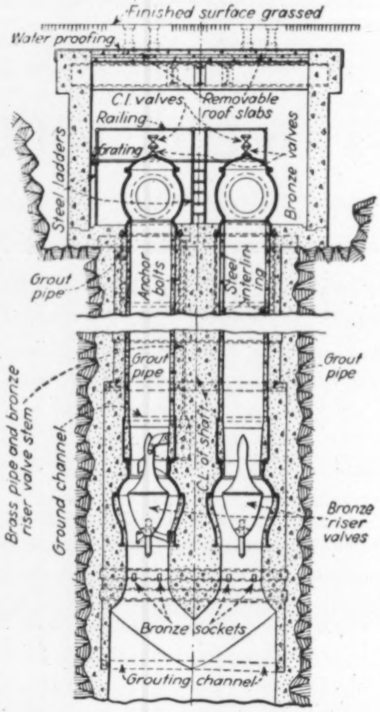


Fig. 2. Riser shaft and valve chamber layout which is used in the 9 shafts provided for supplying water to communities along the tunnel route.

Except for depth, number of riser pipes and other minor differences arising out of local conditions, the three drainage shafts are essentially alike. Each has an outer concrete lining placed as the shaft is sunk, within which the inner concrete and other fixed equipment will be placed only after all tunnel work to be done from that shaft is finished. These outer linings are elliptical at shafts 13 and 23 (about 26 by 23 ft. and 32 by 22 ft. respectively) and circular at shaft 6 (26.5 ft. inside diameter).

The final inner lining of each shaft will be 13 ft. in diameter except for certain inwardly projecting vertical surfaces, designed primarily to afford parallel faces for the attachment of two pairs of bronze cage guides (Fig. 3). At the bottom, the shaft enlarges to a 22-ft. diameter, where a sump is built from 30 to 35 feet deep below tunnel invert. Above the sump an access drift from 100 to 125 ft. long, with its floor 2 ft. above tunnel invert, leads to the tunnel. This drift is closed, when the tunnel is in service, by a massive bronze door of 5 by 7 ft. elliptical clear opening.

A horizontal drift perpendicular to the access drift forms a pump chamber in which the main or station pumps for unwatering the tunnel will be installed. At Shaft 6 this drift will be 17 ft. in finished diameter, 85 ft. long from center of shaft; at shafts 13 and 23, it will be 16 ft. in diameter and 65 ft. long. At Shaft 6 there will be four, and at each of the other drainage shafts three main pumps, horizontal electrically-driven centrifugal units each capable of delivering about 4,500 gpm.

Two cages with their hoists afford vertical transportation for men and materials. The smaller cage is primarily for handling a sinking pump for unwatering the shaft to permit the installation of the station pumps; after the shaft has been unwatered the sinking pump cage will be available for general use. The larger or service cage will always be available for handling men and materials, including the main pumps.

Bronze access doors

The bronze access door and frame will be subject to a very heavy hydrostatic load, totaling about 1,900 tons at Shaft 6. To support this load without putting stress into the immediately adjacent concrete lining of the drift and into the concrete lining of the shaft the bronze door frame is mounted on the end of an assembly of massive elliptical cast-steel backing rings. These surround the access drift and are lined with concrete for protection from rust. External flanges transmit the load into the surrounding concrete, thence to the surrounding rock. To prevent leakage from the tunnel into the access drift, pump chamber and shaft—which might occur in spite of the concrete linings and the thorough grouting of the surrounding rock—a steel-plate interlining completely enclosing all of these structures from the backing rings of the access drift to the top of the shaft will be built into the concrete lining.

Built into the masonry of the shaft, pump chamber and access drift will be all the piping and electrical conduits required for operation, an air duct supplied by blowers at the shaft head for ventilating the pump chamber and cooling the chamber and motors, and a ladderway. Removable steel emergency ladders with landing and rest platforms at about 20-ft. intervals will be erected when the shaft has been unwatered.

The air duct will be formed in the concrete, while the riser for the supply of neighboring communities and the main pump discharge line will be concrete-lined steel pipes. All other built-in piping and all permanent piping and valves in the shaft, access drift, pump chamber and sump will be of bronze, or of copper in the case of some small hydraulic piping. A permanent suction manifold in the floor of the pump chamber with a bronze gate valve on each outlet connects with the tunnel through an embedded bronze pipe leading to a small

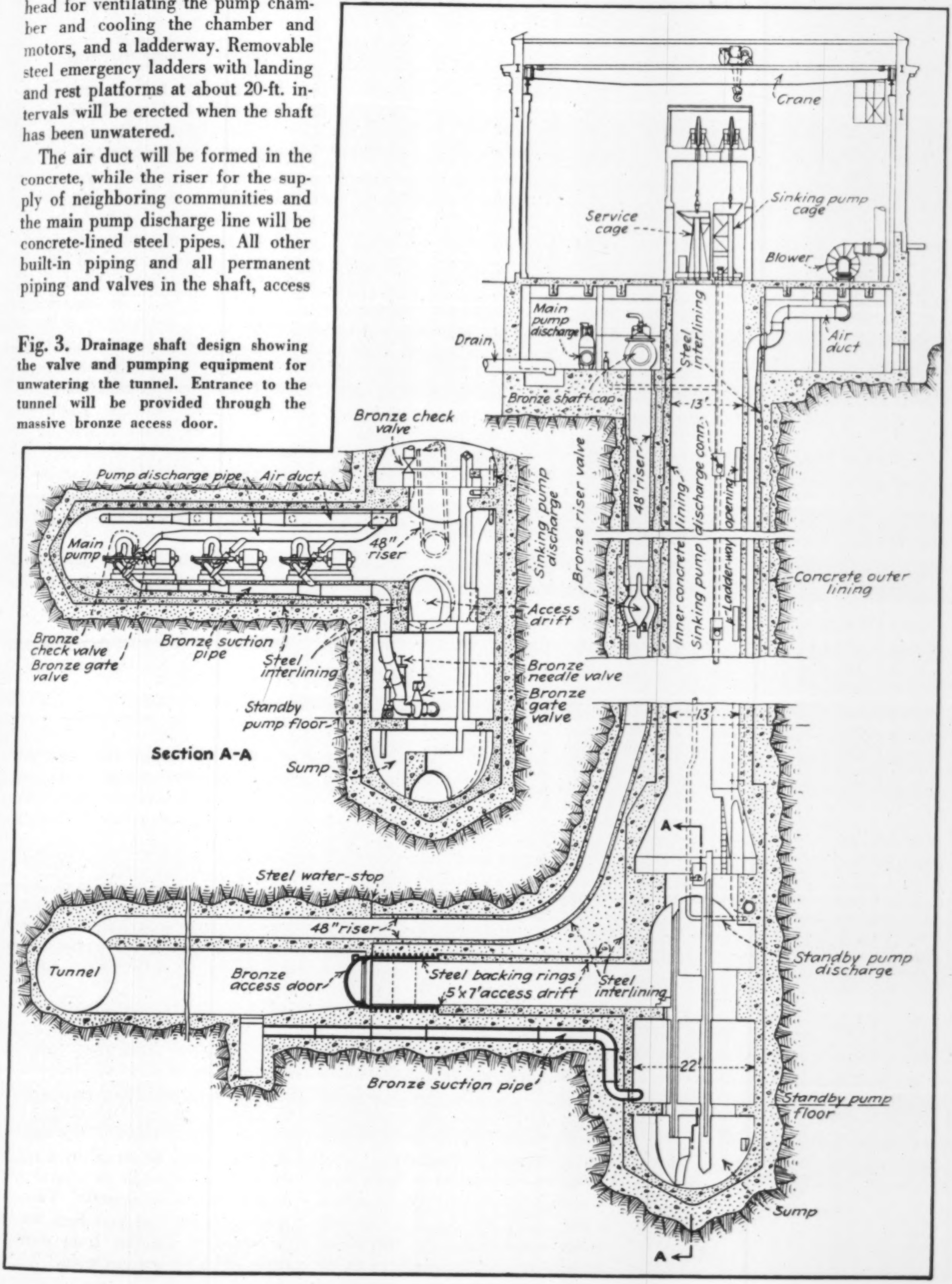

Crane
Sinking pump cage
Service cage
Blower
Main pump discharge
Drain
Steel interlining
Air duct
Bronze shaft-cap
13'
Bronze check valve
Pump discharge pipe
Air duct
Main pump
48" riser
Bronze check valve
Bronze gate valve
Bronze suction pipe
Steel interlining
Standby pump floor
Section A-A
Sump
Sinking pump discharge
Bronze riser valve
48" riser
Inner concrete lining
Sinking pump discharge conn.
Ladder-way opening
Concrete outer lining
Access drift
Bronze needle valve
Bronze gate valve
13'
A
Steel water-stop
48" riser
Tunnel
Bronze access door
Steel backing rings
5'x7' access drift
Steel interlining
Standby pump discharge
22'
Bronze suction pipe
Standby pump floor
Sump
A

Fig. 3. **Drainage shaft design showing the valve and pumping equipment for unwatering the tunnel. Entrance to the tunnel will be provided through the massive bronze access door.**

sump in the invert of the access drift on the tunnel side of the bronze door. A permanent discharge manifold with a bronze check valve on each outlet, suspended from the pump chamber roof, connects the main discharge pipe to the shaft-head. These built-in facilities will reduce to the minimum the time required to install the main station pumps.

The main suction line between the suction manifold and the tunnel will be equipped with a hydraulically-operated needle valve for ordinary operation and with a massive hand-operated bronze gate valve as a guard gate on the tunnel side of the needle valve. The discharge lines will have, in addition to a check-valve at each pump, a master check-valve at the foot of the discharge riser. An 8-in. sinking pump discharge pipe will be built into the shaft lining and equipped, at 35-ft. intervals, with tees carrying 6-in. bronze check valves. These are of special design with their inlets facing the shaft, and they will afford connections for the sinking pump to be used to unwater the shaft. The vertical electrical conduits will permit rapid installation of light, power, control, telephone and signal cables, each having a special suspension at the top of the shaft, when the shaft has been unwatered.

Unwatering the tunnel

It is expected that the shaft will ordinarily be kept full of water to discourage entrance and meddling. To unwater the tunnel a blow-off valve at the shaft head is first opened, draining by gravity all water standing above this level in the connected waterway shafts or in any higher part of the tunnel.

An electrically-driven sinking pump of the multistage centrifugal deep-well type (about 600 pgm capacity against the maximum head) will then be mounted with its motor and discharge connection above the floor of the small or sinking-pump cage. The suction inlet will be about 40 ft. below the cage floor. A flexible, quick-coupling discharge connection on the pump then will be coupled to the highest check valve of the sinking pump discharge line and the water pumped down to the suction inlet. Following this the discharge connection will be uncoupled, the cage lowered to the next check valve, and the cycle repeated.

When the bottom of the shaft is reached a standby pump of about 600 gpm capacity, discharging through the sinking pump discharge line, will be installed on a floor below the access drift and above the sump. This is intended to keep the shaft dry during the remaining operations. At any convenient time thereafter the sinking pump can be hoisted out and its cage freed for general service.

With the shaft unwatered the main station pumps will be installed in the pump chamber, and the tunnel unwatered. With one pump in reserve as a spare, and with no important inward leakage, it is expected that it will require about two weeks after the main pumps have been connected to completely unwater any of the tunnels.

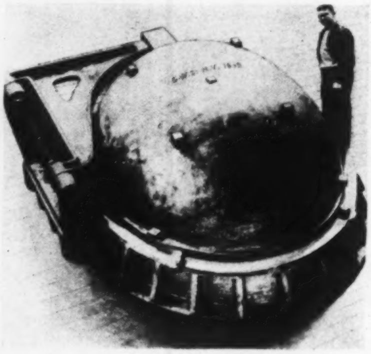


Fig. 4. Massive is the word for the bronze access doors. The semi-ellipsoidal door is 3 in. thick, weighs 10 tons with the frame, and will resist a total pressure of 1,300 tons.

Fireproof superstructure

The shaft-head will be enclosed in a fireproof steel-framed masonry-walled permanent superstructure housing the hoists, blowers, switchboards, office, lavatory, etc., with a basement heating plant. The valves, piping and meters for both the unwatering equipment and water supply to adjacent communities will be in a basement valve chamber. All unwatering equipment will be electrically operated.

Each superstructure will be equipped with a traveling crane serving all equipment within the superstructure and, through removable floor slabs, the heavy equipment in the basement valve chamber. The superstructure at Shaft 6, which is somewhat remote from repair facilities, will contain a small machine shop.

Other articles in the series are scheduled to appear soon.

Testing For Sewer Gas

CONCENTRATIONS of explosive gas in the sewers of Milwaukee, Wis. are being determined by an all-service type of gas indicator. Tests are made by lowering a rubber hose through vent holes in manhole covers to the bottom of manholes above the sewage and withdrawing sewer air into the instrument. The per cent explosibility is read directly on the dial. If the reading is above 20 per cent a test is made in the toxic chamber for carbon monoxide, hydrogen sulphide and hydro carbons such as naphtha, benzene or gasoline. A Wolf safety lamp will show a deficiency of oxygen. If the dial reading is below 20 per cent and no deficiency of oxygen is indicated the survey crew proceeds to the next manhole.

The crew, furnished by WPA, tests 80 manholes per day. The personnel of the squad includes one man who carries and operates the instrument, one who records the readings as the tests are made, and two men who remove manhole covers, erect caution signs and hold red signal flags to protect the other two from traffic hazards while making the tests.

Test have been made daily for more than two years and most of the 27,000 manholes in the city have been investigated. No evidence of dangerous gas concentrations has been found in less than 100 manholes. Primarily the cause has been a clogging of the ventholes in manhole covers preventing the escape of the gas. The crew opens these holes as they proceed.

Explosions, which are rare in Milwaukee, according to George J. Kruell, superintendent of the Bureau of Sewers, may be set off by a spark from a loose manhole or a carelessly dropped match or cigarette. Two explosions in the past have been traced to escape of gasoline from storage tanks and a broken gas main.

Vacuum Cleaner For Septic Tanks

ARTHUR J. LAZENBY
Assistant Engineer, Dept. of Water Supply & Waterworks
Salt Lake City, Utah

***Contents in Brief*—The disagreeable job of hand-cleaning chemical toilets on the Salt Lake City watershed recreational area has been eliminated by the use of a simple vacuum device. Mounted on a small truck, the engine of which produces the vacuum, this cleaning equipment not only expedites the work but also eliminates the unsanitary features of sludge removal from septic tanks.**

THE UNPLEASANT JOB of cleaning chemical tanks has been simplified at Salt Lake City by the development of a vacuum type device which sucks sludge from receptacles directly into a disposal truck without the use of intermediate equipment. The vacuum cleaner, which was designed and built in the shops of the city water department, is truck-mounted and easily moved from job to job.

The machine was built to service the chemical tank toilet facilities which are provided on the wooded property of the water department. Some 125 toilets are installed for sanitary protection on the watershed, which is a popular recreational area.

Prior to 1939 the tanks were cleaned by using a hand pump and buckets. The sludge was dumped into a tank truck and hauled to disposal pits off the watershed. This was a disagreeable and unsanitary job. In spite of the care taken, sludge would be spilled, and the truck and equipment had to be washed every day because of the filthy appearance and putrid odor. Furthermore the pump could not draw the sludge from the last six inches of the tanks, and consequently they were never thoroughly cleaned. Many times the hand pump would clog and loss of time would result while parts were separated and cleaned.

Pumps unsatisfactory

The department tried other types of pumps, but the results were poorer than they were able to get with the hand pump. Centrifugal pumps failed because rags, sticks and papers would accumulate in the impellers and in the suction hose. Pumps with valves would refuse to work when debris caught under a valve, holding it either open or closed, and whenever these power pumps did work for a short time, the suction hose, the pump and the discharge hose would remain filled with sewage, making it necessary to clean the pumps each time they were used.

The work done was so unsatisfactory and disagreeable that the water department began searching for something better. It was then that Jack Salmon, mechanic in the department, conceived the idea of building a vacuum tank which would suck the sludge from the tanks directly into a disposal tank mounted on a truck.

The equipment for this purpose included a 550-gal. cylindrical airtight tank (reinforced to overcome collapse due to vacuum pressure), a 10-gal. auxiliary tank, check valves and hose. The truck motor supplies the power (Fig. 1).

How the cleaner works

Air in the tank is sucked out by means of a tube that goes from the tank to the inlet manifold of the truck motor. The manifold creates an average vacuum of 15 in. of mercury when at the elevation of 4,200 ft. above sea level. The suction from the manifold is taken through a check valve at the entrance to the main tank.

The auxiliary tank is used to stop any fluid that might be sucked from the main tank entering the manifold of the motor. A float valve in the main tank closes when the tank is filled, thus preventing fluid from being sucked into the auxiliary tank. When this float valve closes the vacuum gauge shows a sudden increase in vacuum pressure, thus informing the operator that the tank is full.

The suction line is a ½-in. galvan-

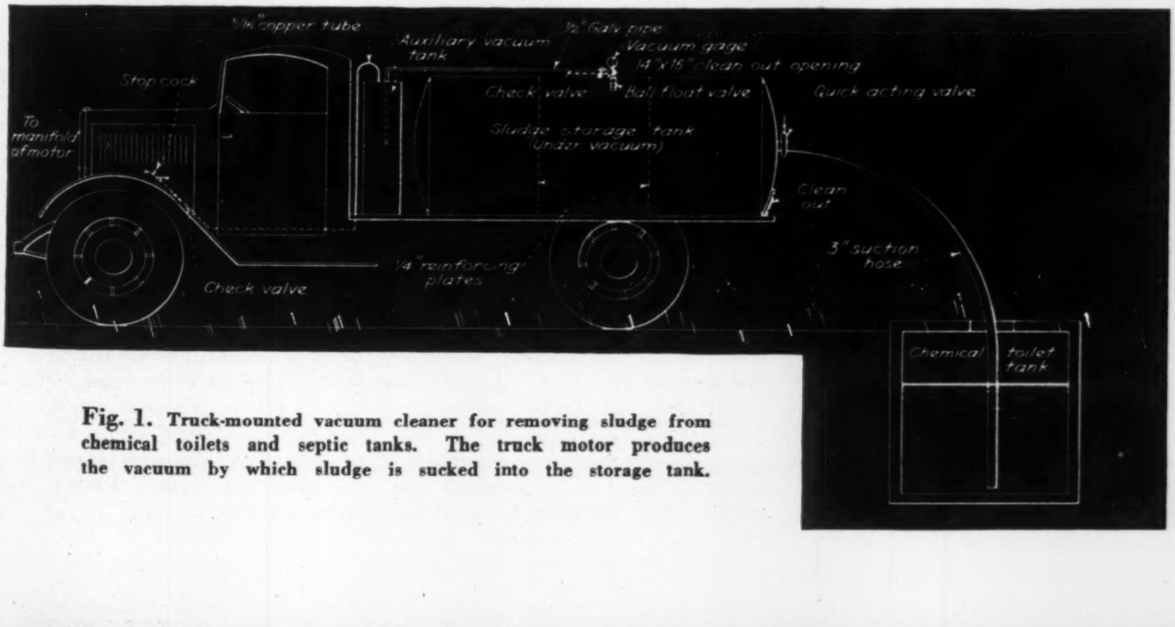


Fig. 1. Truck-mounted vacuum cleaner for removing sludge from chemical toilets and septic tanks. The truck motor produces the vacuum by which sludge is sucked into the storage tank.

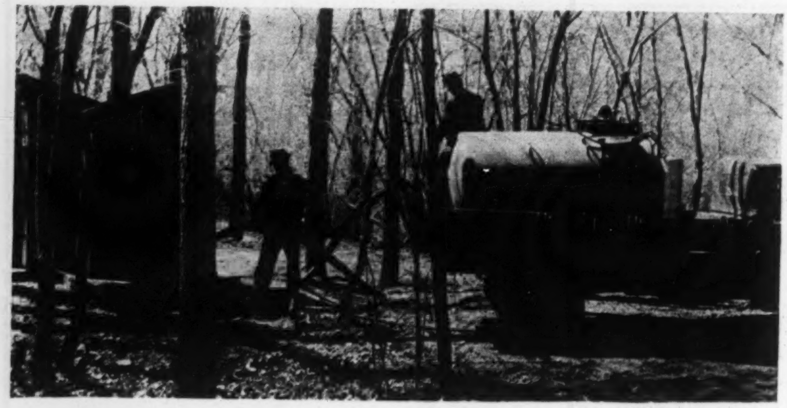


Fig. 2. Servicing one of the 125 toilet installations on the watershed with the homemade "vacuum cleaner."

ized pipe that runs from the top of the main tank to a pipe on the auxiliary tank. The line from the auxiliary tank to the manifold is a $\frac{5}{16}$-in. copper tube.

As the truck moves from one location to another the manifold automatically creates a vacuum in the tank, and operations are ready to start when the equipment reaches the job. While cleaning operations are under way the motor is kept running so that the suction is maintained.

In emptying a septic tank a 3-in. suction hose is attached to a quick-acting valve connection in the back-center of the disposal tank on the truck. All material which might clog the hose is raked out of the septic tank before the hose is inserted; the hose has no screen on the end. After the hose is lowered into the septic tank and the quick-acting valve opened, sludge immediately flows upward into the truck tank.

When the toilet tank is emptied the hose is washed off on the outside by playing a small stream of water on it. About 20 gallons of water are run into the emptied tank and sucked through the hose, thus leaving it clean and free of sludge on the inside.

Efficient at high elevations

So far, this vacuum cleaner has been used successfully at an elevation of 8,750 ft. above sea level using only the vacuum created by the manifold on the truck motor. At this high elevation a vacuum of $13\frac{1}{4}$ in. of mercury is created.

The greater efficiency of the vacuum tank method over the hand pump system is demonstrated in the difference in the time it takes to clean toilet tanks. These tanks have a capacity of 400 gal. and are cleaned when about two-thirds full. With the hand pump it took four men $1\frac{1}{2}$ hr. to clean a tank; with the vacuum equipment it takes three men just 30 minutes to clean the same tank and do a better job.

This scheme was developed by Jack Salmon, mechanic, working under the direction of H. K. Burton, superintendent of water supply and waterworks. George D. Keyser is commissioner of the Salt Lake City water department.

Cross-Connection Control

IN A REVIEW of data obtained from state sanitary engineers by E. Sherman Chase, consulting engineer, Metcalf & Eddy, Boston, and presented to the American Water Works Association at a recent meeting in Kansas City, some of the conclusions that were drawn concerning cross-connection control (i.e. cross-connections between two sources of supply and not inter-connection of plumbing) are:

1. About one-half only of the states have rules and regulations dealing specifically with cross-connections. Practically all state health departments, however, maintain some degree of control of cross-connections acting under their general powers when specific regulations are lacking.

2. Over one-half the state health departments have had no experience with double check valve installations, usually because such installations are prohibited or disapproved in those states.

3. Health departments in the industrial states appear to be somewhat more lenient in the matter of permitting double check valve installation under special conditions but in New York and Tennessee fire pump chlorinators are also required.

4. About one-third of the health departments definitely disapprove or prohibit all cross-connections including those with double check valves.

5. Experience with the modern all-bronze double check valves properly installed and supervised has indicated relatively little hazard of contamination through them.

6. Need exists for the more general adoption of regulations governing cross-connections. Regulations should be based on the principle that an enforcible regulation accomplished more than ideal but non-enforcible prohibition.

7. Regulations should attempt to
   a. Prevent new cross-connections;
   b. Eliminate existing cross-connections in so far as possible and in the shortest practicable time;
   c. Permit continuation of existing cross-connections only in special cases where their elimination would work an economic injustice or replace one hazard by another;
   d. Require such cross-connections as are permitted to remain in existence to be made only by means of all-bronze double check valve installations properly installed and regularly supervised and inspected.

8. Suitable and proper installations of double check valves should be provided on water mains leading into sewage treatment plants and more consideration should be given to such installations on service lines to industrial plants having dual water supplies.

Concrete Lace Curtains for Walls

***Contents in Brief**—To screen a multifloor parking structure in downtown Washington, its sides were curtained with openwork concrete slabs 2-in. thick, hung from the floors. Inside fender curbs protect the curtains from car impact.*

THIN ARCHITECTURAL CONCRETE SLABS were utilized to form an enclosing screen or openwork curtain around a three-story parking structure just built in downtown Washington for the *Evening Star*. The curtain analogy is emphasized by the fact that the slabs hang from the floors instead of resting on each other like blocks of a masonry wall. The novel arrangement, worked out in cooperation by Porter & Lockie, architects, and John J. Earley, specialist in architectural concrete, provided an economical and effective solution of the problem presented by the structure.

Downtown Washington needs extensive parking facilities, and the

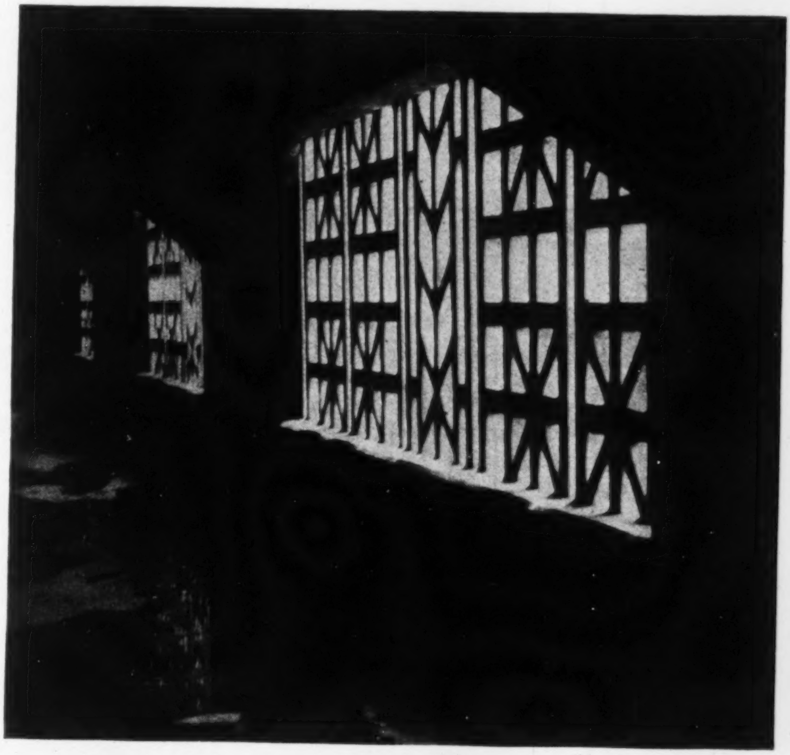


Fig. 2. From the inside the construction resembles nothing so much as lacework.

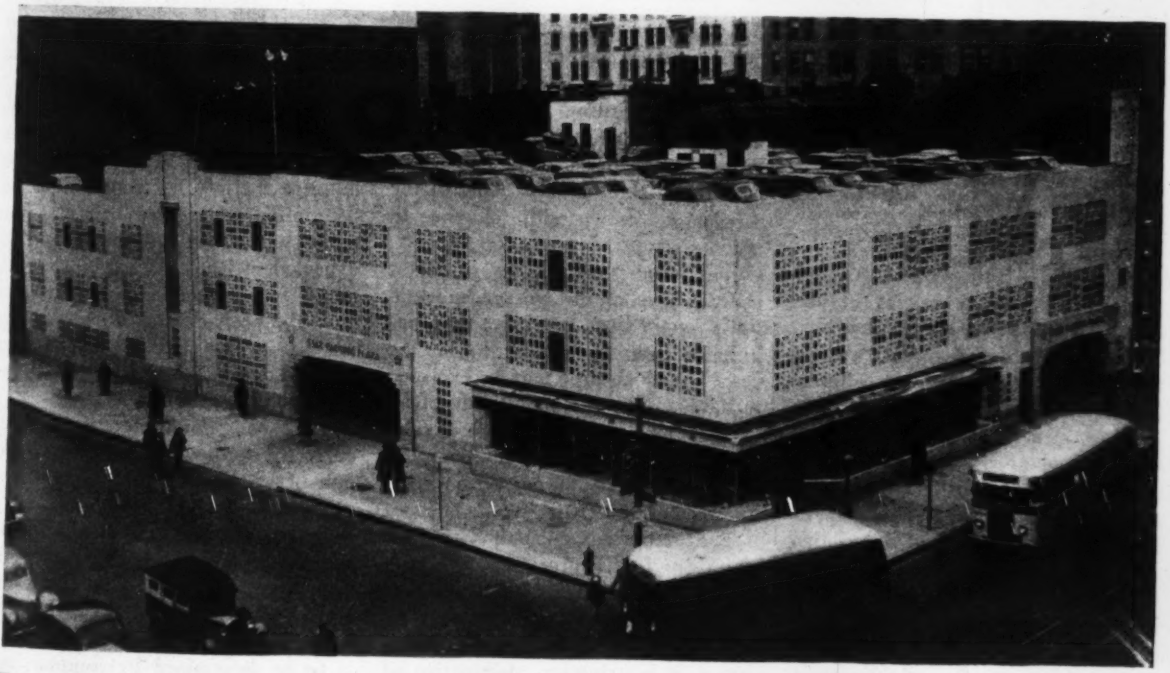


Fig. 1. Slab curtain wall construction makes parking garage in Washington, D. C., an attractive structure.

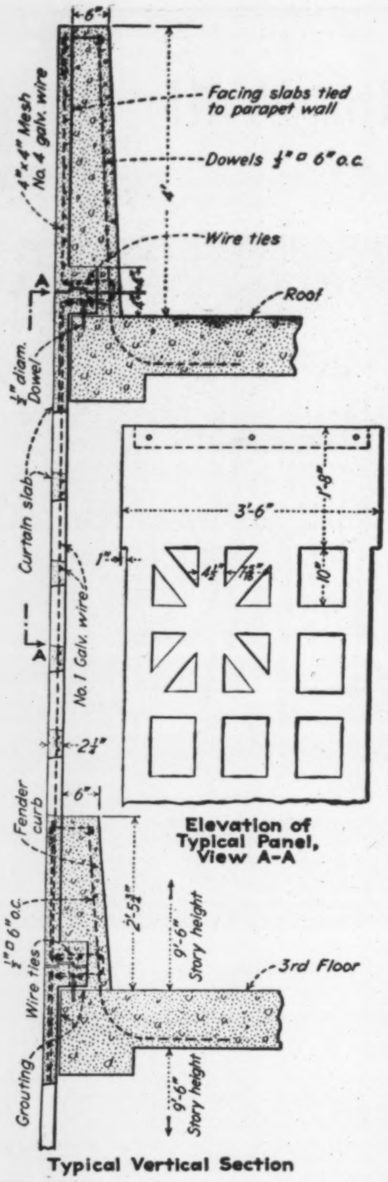


Fig. 3. Typical details of concrete-slab curtain enclosure of Star Garage, Washington.

capacity of a parking lot at the southwest corner of 10th and E Sts., owned by the *Evening Star*, was inadequate for the business offered. Construction of a multi-floor ramp parking structure on the lot was therefore planned, to triple the capacity and in addition to provide garage space for the newspaper's service cars. The cost of a building with enclosing walls of normal type was too high for the intended service, but on the other hand the architects felt that an open parking structure would injure the neighborhood, especially because a high-grade office building occupies the opposite corner.

Under these conditions Mr. Earley proposed curtain construction of openwork slabs, which would provide a low-cost screen involving little or no expense for its support and yet leave the floors sufficiently open to eliminate various items of equipment essential in an enclosed building, such as sprinklers. The plan was approved by the District of Columbia building inspector, Col. J. W. Oehmann, and was carried out by the Charles H. Tompkins Co., builder. Marshall & Congwer designed the structural elements of the building. Mr. Earley cast the slabs in his architectural concrete studio at Rosslyn, Va.

The construction is shown by the sketch section, Fig. 3, while the views, Figs. 1 and 2, bring out the effect obtained. Windowless window openings in the openwork panels on the 10th St. side provide for emergency ingress and egress. A low fender wall of reinforced concrete built against the inside of the curtain in each story forms a stop for parked cars. The parapet is formed by a similarly anchored concrete wall faced with a thin slab like the curtain slabs but seated on the slab below and anchored to the parapet concrete.

Special aggregate gives the curtain slabs a bright, pleasing appearance and luster. The coarse aggregate of the slabs is yellow quartz of about ¼-in. size, and the outer face of each slab was brushed 24 hours after casting to expose the aggregate and then lightly etched with acid to remove remaining cement from the surfaces. The slabs are 2¼ in. thick, and generally are about 3½ x 9½ ft., reinforced with 4 x 4-in. welded galvanized mesh welded to special strips of mesh forming the reinforcement of the bars of the concrete latticework.

The slabs were molded face down in a wooden form, with bottom lining of masonite, shellacked, and cast-iron cores set in to form the openings of the fretwork and the "windows."

Depreciation of Cast Iron Mains Related to Actual Service Life

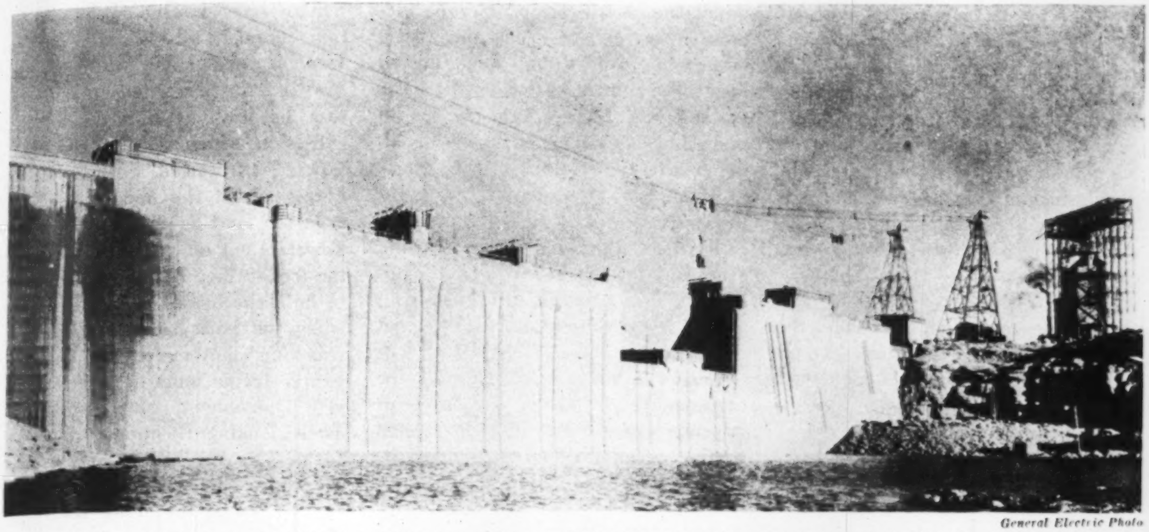
FROM A STUDY of mortality data on cast iron pipe, determined from the records of the Springfield, Mass., system by Reeves Newsom and E. H. Aldrich, consulting engineers, New York, and presented to the American Water Works Association at a recent meeting in Kansas City, some of the conclusions drawn with reference to accounting for depreciation are:

Cast iron pipe systems of water utilities have, on the average, substantially longer lives in service than has hitherto been considered to be the case. Four-inch pipe may be expected to have an average service life of 50 years or more, the service life of 6-in. pipe will average materially over 100 years, and that of larger pipe will be upwards of 150 years.

The straight-line method of accounting for depreciation has no basis of fact or reason other than simplicity to dictate its use; particularly as it affects accounting for water mains, it is arbitrary, destructive of value, exorbitant in its demand upon the early rate payers and bears no relationship to the way in which water mains are retired or depreciate in value.

The compound-interest method, using a 6 per cent interest rate, appears to fulfill the purpose of relating a method of computation for determining depreciation in cast iron mains to the way retirements may be expected, with sufficient reserve to allow for a considerable variation from the basic data used and yet having a substantial provision for accrued depreciation in units of property remaining in service.

The compound-interest method, correctly applied, is little more difficult of application than those based upon straight-line or other arbitrary assumptions and the results of its application are so much more equitable to all concerned that, even if slightly more difficult to apply, its use is warranted where depreciation is to be determined by computation, particularly in long-lived properties.



General Electric Photo

FIG. I. A TYPICAL ELECTRIC CABLEWAY INSTALLATION AS SET UP AT CONCHAS DAM.

Electric Drive for Ordinary Jobs—VI

Special Motors and Controls for Cranes

GEO. H. HALL

Mechanical Engineer, Douglaston, N. Y.

***Contents in Brief**—Cranes with a separate motor drive for each operating function call for elaborate motor-control arrangements. Crane motors also have several modifications including mechanical brakes to fit them for crane service.*

IN RESPECT to electric drive, transporter cableways and cranes have a separate motor drive for each operating function. This use of multiple-motor drive marks the distinction from derricks, draglines and slacklines discussed in the preceding article (*ENR*, May 9, 1940, p. 659). In general, too, cableways and cranes have only a hoisting and conveying function; unlike derricks, slacklines and tautlines, excavation as well as hoisting and conveying is no part of their function in construction. Another distinction is that with multiple-motor drive a series of motors known as crane motors has been developed and also motor-control devices are more complex.

Cable and tramways

Cableways perform much the same duties in construction as do rail-mounted cranes in industrial work. In cableways the track on which the carrier runs is a cable stretched between two towers, both of which may be fixed, one fixed and the other traveling radially, or both having a traveling movement on parallel rails. The load-carrying track may consist of one or any number of parallel cables upon which a carriage carries the blocks for the hoisting cable. A traveling cable is employed for positioning the carriage at any desired point of lifting or lowering. The hoisting and carrying cables are actuated by winding drums operated by separate motors. The hoisting drum motor should be of the wound rotor type and provided with a reversible controller; the equipment for the carrier drum is usually similar but of smaller rating. Both controllers may be manually operated on small cableways, the drum type being used, but it is more customary on all sizes to employ remote control which can be operated by pushbuttons or master switches from the operator's position in a cab placed up on the towers where he can survey the work being performed.

Both of the motors should be provided with magnetic brakes to hold the cables in fixed position when not functioning. The control of the hoisting motor should also be arranged for dynamic braking, or "plugging," to control the speed of the cable when heavy loads are being lowered.

When one or both of the towers are movable on rails, a propelling motor is also needed for each tower and this may be of the wound rotor type with either manual or remote control, depending upon the frequency with which the tower or towers have to be shifted.

Another form of cableway is the aerial tramway which differs in operation from the conventional cableway in that the load does not travel on the cable but with it. Furthermore, tramways are not provided with hoisting equipment but are used solely for the transportation of material. The cable of the tramway is endless and travels over a driving sheave in the head tower and over a loose sheave, with tension takeup, at the tail tower. Buckets, at fixed intervals, may be permanently attached to the cable or they may be of the gripper type so that they can be attached to, or detached from, the cable at will.

Since the cable is in continuous movement, the empty buckets being brought back on the return side of the cable, a single constant-speed motor is indicated for the drive, and this should be of the squirrel cage type to preserve fairly constant traveling speed. Unless unusually frequent stops are involved, a manually operated compensator will satisfactorily meet the requirements of the control.

Usual crane forms

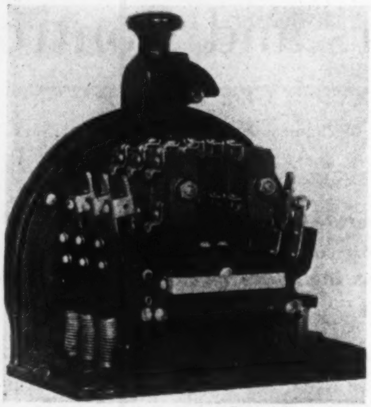
Cranes, as here considered, are distinguished from hoists in that each of the principal movements, at least three, are performed by separate motors. The so-called boom crane is in reality a derrick, although the term crane is often applied to it and, when separate motors are used, it may properly be considered as a crane. The cranes here dealt with are of the gantry or tower types having three principal movements, namely, the hoisting (accomplished through cables), the trolley and the bridge travel; the latter two movements are accomplished through gearing.

Since the work of cranes is practically always of an intermittent nature, they are operated by wound rotor motors of the type specifically classified as crane motors, although these are in many instances employed on other types of hoisting machinery where conditions render them applicable.

Wound rotor motors suited to the intermittent operation of cranes have been standardized by the National Electrical Manufacturers Association under the classification of crane motors. When of the usual open type, crane motors up to and including 40 hp at 900 rpm are rated on the basis of 50 deg. C. temperature rise for 30 min., allowing sufficient time for cooling between operations of this length of time. For motors of larger sizes the rating under similar conditions is based on the temperature rise not exceeding 50 deg. c. for one-hour operation. For all sizes, the breakdown torque is not less than 275 per cent of full load torque.

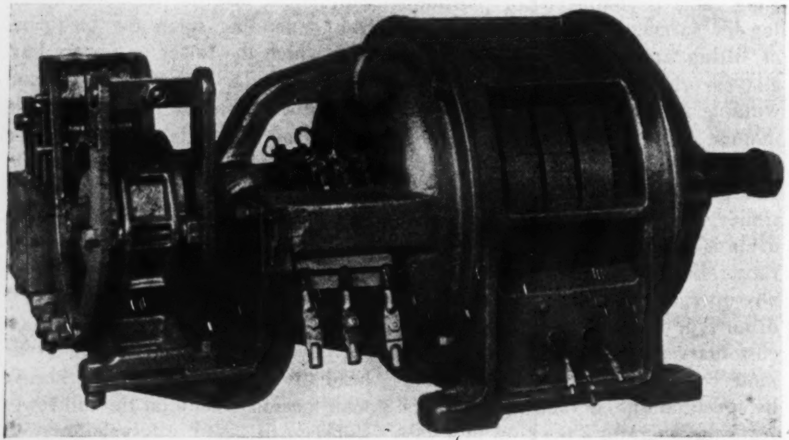
Crane motors which are to be mounted in a cab or any type of housing where they will be protected against weather conditions may be of the open type, but when they are to be mounted out of doors they should be of the splash-proof or totally enclosed type.

Standard crane motors have a number of mechanical modifications specially to fit them for this particular service. One such modification, found in all standard crane motors, is provision for mechanical brakes. This necessitates that the motors be built with a double shaft extension which may be straight or tapered as desired. Such a brake is necessary on the hoisting motor to hold the load against lowering when power is cut off from the motor. On the trolley motor the brake is needed to hold the trolley in locked position when the hoist is in operation; the traveling motor for the tower or gantry frame must be locked to prevent movement after positioning. These locking functions are all performed by the use of brakes which are applied to brake wheels mounted on the end of the motor shaft opposite to that by which the gears are carried. Normally, when no current is flowing to the motor, the brake shoes are held in strong spring contact with the brake wheel so that the motor is locked against rotation. When current is applied to the motor it also energizes a solenoid, or actuates a thrustor, which raises a set of arms with their shoes and releases their hold on the brake wheel. Such brakes are connected in series with one phase of the rotor circuit. Solenoid load brakes, connected to a phase of the stator circuit, are also frequently used on hoist motors to provide a restraining torque when lowering a load. This prevents "backlash."



General Electric Photo

Fig. 3. Reversing master control switch used with a contactor panel in magnetic control of crane motor drive (cover removed).



General Electric Photo

Fig. 2. Motor with solenoid brake as designed for crane operation.

For hoisting motors which are not provided with load brakes, the loading may be controlled by regenerative and reverse torque braking, commonly known as "plugging." The plugging, which is really a feature of control rather than motor construction, consists of the establishment of connections so that the motor, as it is rotated in reverse direction by the pull of the descending load, acts as a generator and causes current to flow back into the lines. Such action places a restraining load on the motor to an extent which may be graduated by the selective use of various sections of resistance so that slow and controlled lowering speeds result.

Crane motor control

Since there are at least three motors to be controlled, and on the larger cranes a greater number, it is desirable that all controls be assembled at an operating point—usually in the cab—which provides a clear view of the work.

As previously mentioned, the use of the wound rotor motor is general practice for the operation of crane drives, and these may be controlled by either manual or magnetic controllers in connection with suitable secondary resistances to reduce excess flow of current in starting.

The controller for all of the crane motors is, in effect, a device by which a number of contacts are established in the rotor circuit through numerous successive steps of resistance which are progressively cut out of the circuit until the motor has attained its full load speed. With crane motors this full load speed is the synchronous rated speed of the motor less its "slip," which amounts to about 10 or 15 per cent.

The use of the manual controller is limited by the capacity of the motor since the contacts of such a controller must handle the full secondary current which flows to the rotor. For this reason it is seldom employed for use with motors exceeding 100 hp. The manual controller may be of the enclosed drum type or of the open-face "dinky" type and when used on hoisting motors it is customary to allow a permanent block of resistance to remain in the circuit even when the controller handle is placed on the full-speed point. This provides against stalling of the motor and also offers a limitation to the current in case the controller handle is operated too rapidly, since it limits the current peak.

Magnetic control employs a master switch and a contactor panel. All current to the rotor circuit is handled by the magnetic contactors, one being required for each step of resistance. These contactors are caused to function by a master switch. The master switch establishes pilot circuits to each of the contactors successively and the pilot circuits involve comparatively small currents since the current to the motor is handled entirely by the contactors, which may be of as heavy capacity as the motor demands. Before starting, all of the contactors are in open position and the circuit passes through all of the resistance bank. As the contactors are successively closed, a definite step of resistance is cut out of the circuit until all of the steps, except such as are to remain permanently in the circuit are short circuited. To prevent applying increasing current to the motor at too rapid a rate, the contactors use time-limit acceleration which automatically, by delayed action relays, restrains each contactor from closing for a definite time after the previous contactor has functioned, regardless of the speed at which the master switch may be turned. The relays are operated by direct current, furnished by the use of copper-oxide rectifiers.

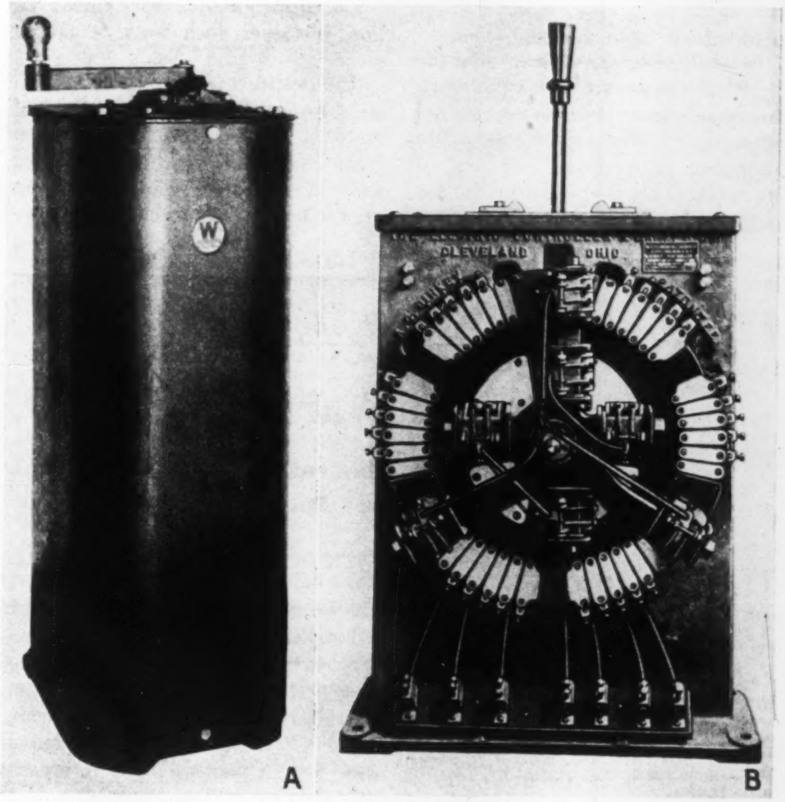


Fig. 4. Two common forms of crane-motor controllers: (A) Drum type (Westinghouse photo) and (B) open face Dinkey type (Electric Controller & Mfg. Co. Photo).

Electrical braking or plugging, as previously described, is also accomplished by the operation of the master switch operating in conjunction with the magnetic control panel.

In connection with hoisting motors, protective devices are required for both overtravel and overload. The overtravel protection is in the form of a limit switch in the main line circuit. On the hoisting cable there is placed a stop bracket which, when the cable is as high as it should go, contacts with a lever of the switch, releases the tension of the closing weight or spring and permits the switch to act, thus opening the circuit to the motor which at once stops. As soon as the cable is again lowered below this stop point, a counterweight recloses the switch and restores the circuit so that normal operation may proceed. Such protection is vital to the safety of the hoisting mechanism, which would be seriously damaged should the cable with its hook be drawn up into the driving parts of the hoist.

A second protective device essential for use with all crane motor control is the panel for the protection of the motors against overload and undervoltage. This panel is usually mounted in the cab in juxtaposition to the other control elements. On this panel there is mounted a gravity-reset overload relay for each of the motors comprising the equipment. These relays are operative whenever overload peaks occur. The equipment also comprises a magnetic line contactor, with "stop" and "reset" pushbuttons, which provides undervoltage protection since it will automatically open the main circuit upon failure of the line voltage. A knife switch, with line fuses, provides for manual opening of the supply lines when it is desired to render the entire equipment inoperative. Pilot lamps mounted on the face of the panel indicate when power is on or off from the main line.

In addition to the protection of the electrical elements of the equipment, this panel also provides protection for workmen who may be engaged in inspection or repair of any part of the outfit. This is effected by the use of padlocks on the main line switch so that it may be locked in open position whenever such work is taking place.

The resistance, or resistor, which must be supplied for each individual motor is in the form of an open framework upon which are mounted coils of edgewise resistance ribbon or, for heavy duty machines, a number of cast iron grids. The latter is the more common form for cranes of the capacity that would ordinarily be employed in construction work. The resistors are installed in the cab so as to necessitate comparatively short connections and should be so placed as to be open to a free circulation of air around them.

Caution in Contracting Is War's Warning

Ralph F. Proctor*

Association of Casualty and Surety Executives, New York

***Contents in Brief**—Large losses suffered by contractors in 1917–18 as the result of war-service diversion of materials and labor and increased prices are warnings of present possibilities. Relief legislation passed after the World War proved to be ineffective to compensate for these losses. For this reason the author urges advance provision of contract safeguards, prudence in bidding and maintenance and accurate cost records by contractors. His remarks are taken from a recent address before the Carolinas Branch of the Associated General Contractors.*

No industry is more sensitive to economic changes than the construction industry. It is the largest industrial employer and is one of the most hazardous lines of business undertaking. During the performance of a contract the original conditions may entirely change, causing irreparable loss. World War experience is significant in this respect.

Up to the spring of 1917, certain lines of industry were busily engaged in carrying out foreign contracts. General construction work designed to meet the normal demands of our government and states was little affected as to program, though there was some stiffening in price and some difficulty in securing deliveries of certain materials. The possibility of our being thrown into the conflict overnight did not seem to have any effect on the willingness on the part of contractors to undertake work requiring long periods of time for completion. But after the declaration of war on April 6, 1917, this country found itself with a man-sized job to create, equip, train and transport an army, the United States Government took over the construction industry for its immediate needs. Materials and labor were diverted, contracts considered not vitally necessary were not started, certain contracts were ordered discontinued, and the industry as a whole was disturbed. Serious losses resulted to contractors.

After the war was over, relief legislation was passed by Congress and some of the states, and some contractors received reimbursement for losses due to delays and increased prices. Many, however, were not benefited by such legislation, because it was impossible for them to establish the facts or because there were many items which caused them additional and unforeseen expense for which they could not be reimbursed. Many had experienced such difficulty with labor and material that they abandoned their contracts; others had carried on until their substance was exhausted and they were forced to abandon. Thus, small comfort may be had from possible relief legislation after the event.

Right now, a number of problems must be provided for, as has been pointed out by the Associated General Contractors: "First, the case of delays or suspensions resulting from the emergency by providing for the adjustment of the contract price under the article in the contract dealing with changed conditions. Second, providing for the adjustment of the contract for changes in prices of materials or wage rates by reason of the emergency. Third, providing for termination of the contract where made necessary by the emergency, and establishing specific conditions under which settlement is to be made." The industry should lose no time in exerting every effort to make such proper and reasonable safeguards an actuality.

In the meantime individual members of the industry should tender for new work with due precautions. This is no time to consider price competition, trusting to a break; it is no time to bid in the hope of turning an old dollar into a new. There should be no speculation in the purchase of materials. Prices should be obtained from concerns of known stability and plant capacity to carry out their engagements.

The same thing holds true as to speculation on work let under a subcontract. If there is any doubt in the bidder's mind about the subcontractor's price or ability to perform, the contractor should demand adequate security or else sublet to someone whose performance record warrants it even though the price is higher. Operations should be confined to localities where the constructor is known, where his credits have already been established and where he has complete knowledge of the local labor and material markets. Long-term contracts should be avoided, unless they include provisions giving relief in case of war emergency.

Finally, one of the most important considerations at the present time is complete and accurate records of costs. Every contractor should be sure to build accurate and true records that will show convincingly the effect of any increased costs or changes chargeable to war conditions.

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* *As we go to press, news comes of Mr. Proctor's death following an operation.*

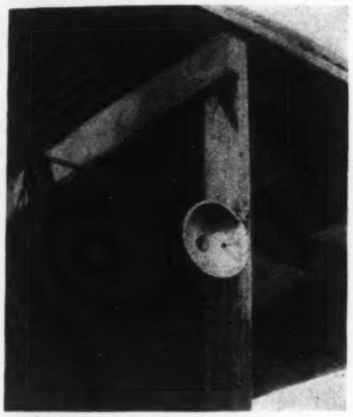
FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Headlights for Spotlights

M. T. Pate
Longview, Tex.

Spotlights for construction operations were devised by one contractor from old car headlight reflectors as illustrated. The center hole in the reflector is simply slipped over the base of the bulb and brings the filament of a 75 or 100-watt bulb so nearly into the focus of the curve on which the reflector is built that a powerful, concentrated ray results.



Headlight reflector salvaged from junked automobile makes good job spotlight.

When used with standard weatherproof sockets, these reflectors are protected against contact with or grounding of the lighting circuit, or may be backed with a loose gasket of asbestos material as additional precaution against electrical trouble. If gasket material is used as insulator, care must be taken to be sure it is not of the wire-inserted type, which is a conductor.

• • •

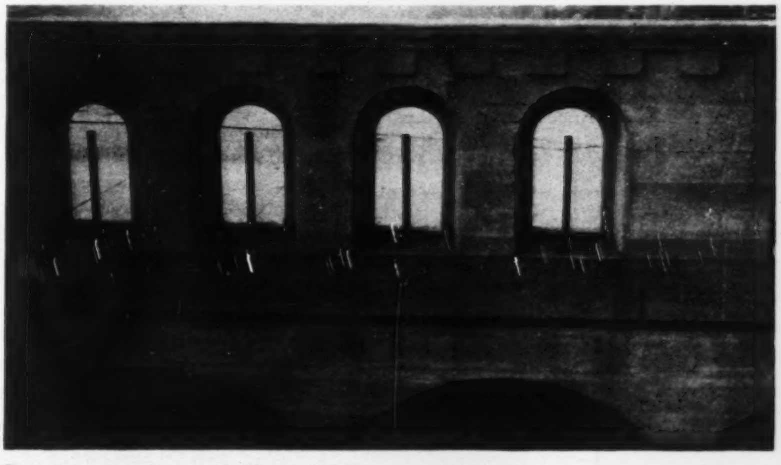
Bridge Beautification That Didn't Work

Queer metal rods observed projecting upward into the openings of a concrete bridge railing in California were explained as follows: Small children crossing this bridge on their way to a nearby school thought it fun to play in and out of these openings which are readily accessible from the sidewalks. The openings are a foot wide and two feet high and the 12-in. wall thickness made an attractive seat. Hence hide-and-seek games were popular until city officials were reminded of the risk. As a result, not only were 1-in. galvanized pipes grouted into holes made in the existing openings, but when it became necessary to extend one end of the bridge, the requirement of uniformity had to be observed and the new railing was made with openings of the same size in which were put pipes 2½ ft. long imbedded 12 in. in the concrete.

An interesting commentary is that when the bridge was built the construction engineer protested about the design because of this risk in the large openings. He was overruled because the design was one submitted by a group of architects campaigning for a policy of beautifying city bridges.

BRIEF MEMORANDA

Salt blocks normally used by farmers as "salt licks" for cattle are used by the engineering department of Verdun, Quebec, to keep catch-basins from freezing. About a block a month is dropped into each basin; this maintains a brine sufficiently concentrated to keep the drains open under all ordinary conditions.



Dangerous openings in bridge railing protected by bars.

Simple Density Test

William S. Foster
Stanley Engineering Co.
Muscatine, Ia.

The apparatus illustrated was developed by W. B. Spangler, engineer for the city of Jefferson, Iowa, and the writer to determine the density of a rolled bituminous wearing surface being used on street construction. It consists of a tin can with a lip cut 1 in. wide and 2 in. long bent concave to form a spout. By cutting the notch in this way, one is sure of having the same amount of water in the can for each test. Tests showed the water to be constant within one-half gram.

Apparatus for bituminous density test.

The method of the test is first to fill the can with water over the level of the notch, letting the excess run out; then slowly lower a previously weighed sample into the water, catching the displaced water in a bowl or graduated tube. The relation of the weight to the displaced volume will give the density of the specimen.

Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

FUEL OIL—Dry distillation of various types of organic matter is a source of fuel oil. The possibilities and yield of crude oil obtainable from various types of sewage sludges have been investigated by Shibata (*Journal*, Society Chemical Industry, Japan, Vol. 42, p. 38, 80, 165, 1939). The amounts of oil obtained varied with the type of sludge and the degree of digestion. The longer the digestion time, the smaller the amount of oil, but the reduction in oil yield was not in proportion to the increase of gas produced. The crude oil yield expressed in percentage by weight on the basis of total dry solids in the sludge for the different sludges, determined in the laboratory and on a pilot plant basis were as follows:

	Per Cent
Raw stale sludge	11.5 to 12.0
Raw sludge and garbage	8.5
Raw activated plus garbage	14.0 to 20.0
Digested activated plus garbage	10.2 to 15.6

Digestion of mixtures of primary and activated sludge for a period of 20 to 30 days is considered best, because the gas produced can be utilized for heating the digestor as well as the retort for distillation, making it a self-contained process yielding crude oil and a residue.

The higher yield of activated sludge is explained on the basis that more bacteria and protozoa are present in the floc than in raw sludge, similar to the plankton theory of the origin of petroleum. The author is not free to publish details on the hydrogenation of the oil obtained, but from the data submitted, it appears that the gasoline produced is very close to gasolines used for aviation purposes.

MILK WASTE—Milk and whey washings treatment on trickling filters after proper settling and dilutions has been studied for several years by the Water Pollution Research Board of England. Previously the large-scale experiments have been conducted under unfavorable conditions during the winter when the temperature is low and the quantities of waste produced are smallest. Purification by double filtration on trickling filters in series (*Annual Report* of the Research Board 1939) during spring and summer, with periodic change in the order of the filters produced well oxygenated effluents of good quality.

Liquid	Rate gal/c.y.	B.O.D. crude	B.O.D. primary filter	B.O.D. secondary filter
Whey (spring)	132	210	13	6
Whey (summer)	160	270	28	7
3 vol. Whey + 1 of milk	160	290	8	7

All effluents contained high proportions of nitrate and the dissolved oxygen concentration was never much less than that corresponding to saturation. Treatment by the activated sludge process, allowing 36 hours' aeration, produced approximately the same results.

PARTIAL ACTIVATED SLUDGE—It is very difficult to adapt an existing plant to sewage which has undergone a radical change in character, resulting in decreased efficiency, overloading and attendant nuisances. The mechanical aeration activated sludge plant at the Yardley works of Birmingham, England, has been utilized to adapt the partial activated sludge process in combination with chemical treatment and trickling filters. A further step of the "split and return" system used at another plant in Birmingham (*ENR*, Dec. 10, 1936, P. 819), where iron wastes and increased organic impurities are received, is discussed in the 1938-39 Annual Report of the Birmingham Tame and Rea Drainage Board.

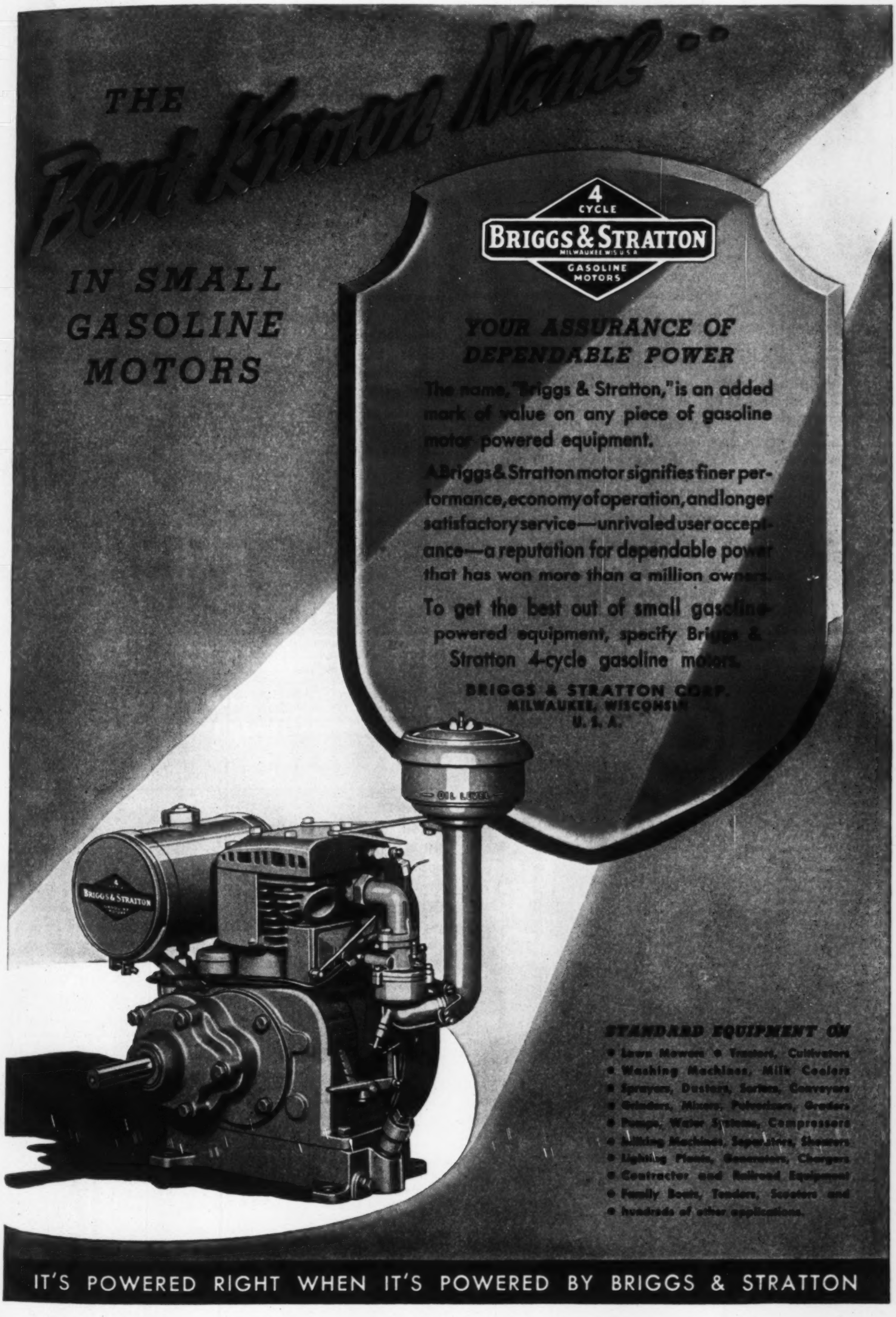
The method of treatment at these enlarged works comprises lining of the crude sewage, followed by a short period of aeration with a mixture of settled activated and trickling filter humus sludge. This pretreatment removed the iron and coagulated the sewage solids, which are settled in mechanically cleaned clarifiers. The settled liquor then passes to an activated sludge tank where it is aerated for 1 to 2 hours with properly reconditioned activated sludge. After settling the sewage is distributed over rectangular trickling filters, settled and discharged. The iron-lime treatment, followed by partial activation and filtering produces an effluent with low B.O.D. has restored the efficiency of the overloaded filters and caused the removal of much accumulated sludge in the filters.

WAR AND SEWERS—One of the hazards in any country at war through bombing attack of large centers of population is the possible damage to main sewers. In many instances a broken sewer would result in a particularly objectionable type of flooding, which may be serious to the community in many ways. The problem can be dealt with only by the provision of alternate courses for sewage flow interrupted by broken sewers. In England (*The Surveyor*, Dec. 29, 1939) one of the largest systems has been provided with means to isolate damage sections and bypass sewage through existing surface watercourses. Bypass outlets are built in such a way that a rising sewage level, following isolation of the damaged section, automatically opens the outlets. The isolation is provided for by emergency sluice gates.

The gates are controlled by a simple hoisting mechanism with a clutch; they are normally suspended above the sewage level and in emergency released by withdrawal of the clutch; thus the gate will descend by its own weight at a controlled speed to close off the sewer. Declutching is effected by fitting a standard lever to the operating bar, which is accessible through a manhole. The installation can be carried out above the sewage level without interruption of the flow or disturbance of the sewer. The seal between the gate and sewer is made around the contour of the gate, the seal having sufficient flexibility to insure full seating.

THE ELECTRIC EYE as a turbidity indicator in aeration tanks has been in use for some time at Tallman's Island activated sludge plant with a fair degree of success.

THE SWEEPING ACTION of sewage distributors is said to determine to some extent the relative abundance of Psychoda fly in various parts of the beds at Leeds, England.



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CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

DENISON DAM TEXAS AND OKLAHOMA

OWNER: U. S. Engineer Office, Denison, Tex., Capt. L. D. Clay, district engineer.

PROJECT: Construction of Denison Dam and Reservoir embankment and excavation for spillway which includes excavation of approach channels for river diversion and filling approach to service bridge. Rolled-fill embankment extends from Sta. 14+50 on Texas side approximately 16,850 ft. in northerly direction across Red River near Denison, Tex., to Sta. 183+00 on Oklahoma side. Embankment contains about 17,000,000 c.y. of fill. Maximum width 2,000 ft.; top width 40 ft. Excavation for spillway located near south end of dam involves 11,000,000 c.y. of excavation.

CONDITIONS: Contractor to furnish all materials except sand and cement for grouting. Rail and highway transportation available. Project to be completed in 1400 calendar days. Wage rates specified are: skilled labor, $1.00 to $1.25 per hr.; semi-skilled, 62½ to 80c.; and common, 40c. per hr.

BIDS: Nine bids were opened April 16, 1940, ranging from the contract low of $8,228,465 to $9,970,623.

LOW BIDDERS:

1. Guy F. Atkinson Co., San Francisco, Calif.	$8,228,465
2. W. E. Callahan Constr. Co., Dallas; George W. Condon Co., Omaha, Nebr.; and J. P. Shirley, Los Angeles, Calif.	8,368,594
3. Brown & Root, Inc., Austin, Tex.; R. W. Briggs, Pharr, Tex.	8,385,265

Item	Quan.	Unit Prices		
		(1)	(2)	(3)
1. Diversion, care of water	L.S.	$100,000.00	$10,000.00	$45,250.00
2. Grubbing	L.S.	42,500.00	40,000.00	37,000.00
3. Foundation preparation	70,000 sq.*	.20	.08	.025
4. Foundation cleanup	2,200 sq.*	8.00	3.00	4.75
5. Drill grout holes	6,000 l. f.	.50	.60	.18
6. Black steel pipe	4,800 lb.	.30	.18	.19
7. Foundation grouting	7,300 c. f.	1.20	1.15	1.20
8. Excavation stripping	1,200,000 c. y.	.12	.11	.13
9. Excavation, foundation	10,000 c. y.	.85	.80	.27
10. Rock excavation	4,000 c. y.	1.50	10.00	1.75
11. Slump area excavation	480,000 c. y.	.35	.25	.33
12. Discharge channel excava.	120,000 c. y.	.20	.18	.15
13. River sand excavation	40,000 c. y.	.15	.16	.30
14. Trench excavation	120,000 c. y.	.22	.20	.15
15. Excav., borrow area A-1	4,010,000 c. y.	.125	.14	.17
16. Excav., borrow area A-2	500,000 c. y.	.125	.14	.18
17. Excav., borrow area B	1,090,000 c. y.	.165	.16	.155
18. Excav., borrow area C	4,240,000 c. y.	.165	.17	.165
19. Excav., borrow area D	600,000 c. y.	.145	.14	.165
20. Excav., borrow area E-1	2,260,000 c. y.	.125	.14	.16
21. Excav., borrow area E-2	2,910,000 c. y.	.125	.14	.155
22. Excav., borrow area O	580,000 c. y.	.13	.17	.165
23. Excav., borrow area P	110,000 c. y.	.20	.11	.13
24. Excav., borrow area S-1	1,780,000 c. y.	.19	.19	.175
25. Excav., borrow area S-2	4,850,000 c. y.	.22	.30	.275
26. Excav., borrow area S-3	4,124,500 c. y.	.20	.24	.255
27. Excav., borrow area Z	370,000 c. y.	.12	.16	.15
28. Excav., borrow (wasted)	1,380,000 c. y.	.10	.08	.12
29. Steel sheet piling	290,000 s. f.	1.32	1.15	1.50
30. Rolled fill, impervious	6,980,000 c. y.	.08	.06	.04
31. Rolled-fill, pervious	3,650,000 c. y.	.065	.04	.035
32. Rolled-fill, random per.	5,150,000 c. y.	.08	.05	.04
33. Blanket and berm	1,590,000 c. y.	.04	.02	.015
34. Roll, add l. 2 trips	8,000,000 sq.*	.0085	.01	.005
35. Gravel, road	9,000 c. y.	2.00	2.00	2.50
36. Gravel, drains	90,000 c. y.	2.60	2.00	2.50
37. Coarse sand and gravel	102,000 c. y.	1.90	1.80	1.50
38. Spalls	106,000 c. y.	2.40	2.50	2.75
39. Riprap	100,000 c. y.	3.00	3.50	3.00
40. Derrick stone	6,000 c. y.	4.00	6.00	3.00
41. 6-in. corr. metal pipe	4,700 l. f.	1.40	1.50	1.50
42. 8-in. corr. metal pipe	2,400 l. f.	1.75	1.80	1.75
43. 10-in. corr. metal pipe	2,300 l. f.	2.00	2.10	2.00
44. 12-in. corr. metal pipe	2,200 l. f.	2.50	2.30	2.25
45. 18-in. corr. metal pipe	3,800 l. f.	3.00	3.50	3.00
46. 30-in. corr. metal pipe	1,700 l. f.	7.00	6.50	6.50
47. 30-in. corr. metal pipe, perf.	3,000 l. f.	7.75	7.00	6.50
48. Corr. met. manhole	6 ea.	800.00	500.00	600.00
49. Corr. met. catch basin	179 ea.	140.00	125.00	125.00
50. Metal flume	72,000 l. f.	1.20	1.60	1.25
51. Settlement gages	L.S.	20,000.00	10,000.00	4,000.00
52. Guard rail	29,300 l. f.	.75	.90	.80

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* 100 square feet.

ROAD SURFACING SOUTH DAKOTA

OWNER: South Dakota State Highway Commission, Pierre.

PROJECT: Oil surfacing, plant mix method, 19.426 miles of road in Brookings and Moody Counties, S. Dak.

CONDITIONS: Contractor to furnish all material except gravel, which will be furnished by counties. Rail and highway transportation facilities available. Project to be completed in 100 weather working days. Wages are: skilled labor, 75c. per hr.; semi-skilled, 55c.; and common, 45c.

BIDS: Eight bids were opened March 12, 1940, ranging from the contract low of $84,210 to $115,918.

LOW BIDDERS:

1. Haggart Constr. Co., Fargo, N. Dak. (contract)	$84,210
2. Inland Constr. Co., Omaha, Neb.	86,087
3. Megarry Bros., St. Cloud, Minn.	86,412

Item	Quan.	Unit Prices		
		(1)	(2)	(3)
1. Pit stripping	7,720 c. y.	$0.10	$0.20	$0.10
2. Remove boulders	10 c. y.	1.00	2.00	1.00
3. Filler or fines	2,471 ton	1.15	1.00	1.00
4. Sand for seal coat	1,961 ton	1.00	1.30	2.00
5. Sand haul	39,209 ton ½-mi.	.025	.02	.02
6. Trenching and shouldering	19.426 mi.	50.00	20.00	50.00
7. Rolling	19.426 mi.	25.00	21.00	30.00
8. Furn. RC-1 liquid asph	36,489 gal.	.06	.065	.065
9. Apply RC-1 liquid asph	36,489 gal.	.0125	.015	.015
10. Furn. MC-5 liquid asph	392,318 gal.	.0582	.09	.0675
11. Plant mix material	29,035 ton	1.49	1.08	1.35
12. Bring in oversize material	4,910 ton	.65	.35	.70
13. Furn. RC-3 liquid asph	57,677 gal.	.06	.085	.065
14. Apply RC-3 liquid asph	57,677 gal.	.0125	.015	.015
15. Incidental work	L.S.	75.00	850.00	250.00

GUIDE WALL EXTENSION PENNSYLVANIA

OWNER: U. S. Engineer Office, Pittsburgh, Pa.; W. E. R. Covell, district engineer.

PROJECT: Construction of upper guide wall extension and appurtenant work at Lock No. 5, Allegheny River, near Freeport, Pa.

CONDITIONS: Contractor to furnish all materials and complete work in 150 calendar days. Road, water and rail transportation facilities available. River must be kept open to traffic. Other contractors near site must not be interrupted in their work. Wage rates are: skilled, $1.00 to $1.50 per hr.; semi-skilled, 75 to 95c.; and common, 65c. per hr.

BIDS: Ten bids were received April 5, 1940, ranging from contract low of $51,338 to $76,025.

LOW BIDDERS:

1. John F. Casey Co., Pittsburgh, Pa. (contract)	$51,338
2. J. T. McCarthy Co., Davenport, Iowa	58,932
3. Industrial Contractors, Irwin, Pa.	59,404

Item	Quan.	Unit Prices		
		(1)	(2)	(3)
1. Cofferdam	L. S.	$7,000.00	$9,600.00	$9,000.00
2. Steel sheet piling	21,565 s. f.	.92	1.20	1.10
3. Gravel fill	1,605 c. y.	.92	1.00	2.00
4. Concrete	1,165 c. y.	14.00	11.00	15.00
5. Reinforcing steel	15,215 lb.	.06	.05	.04
6. Structural steel	40,210 lb.	.06	.10	.065
7. Bolt steel	185 lb.	.20	.20	.105
8. Cast steel	24,680 lb.	.13	.15	.105
9. Cast iron	170 lb.	.20	.17	.10
10. Sheet copper	10 lb.	2.50	.65	1.00
11. Electric cable	225 l. f.	.25	1.90	.50
12. 1½-in. conduit	25 l. f.	1.00	2.00	1.00

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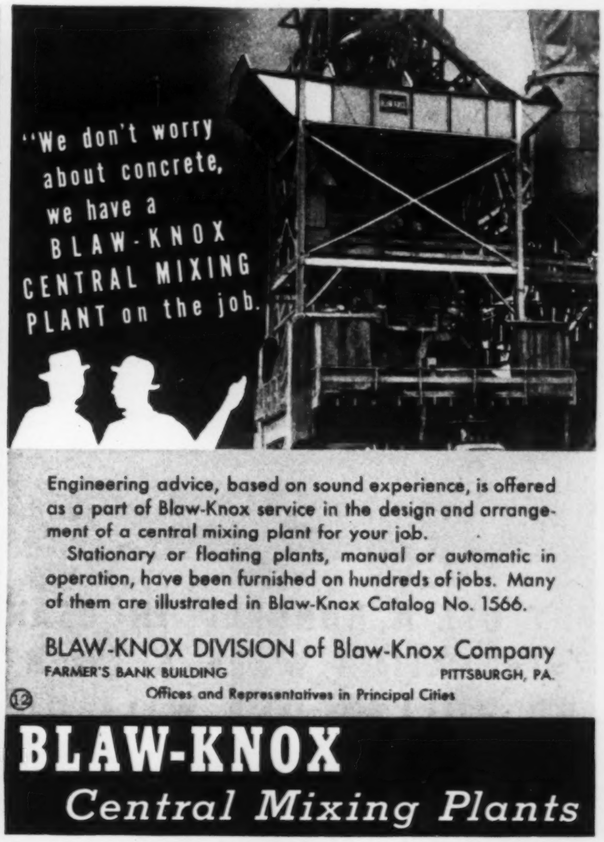

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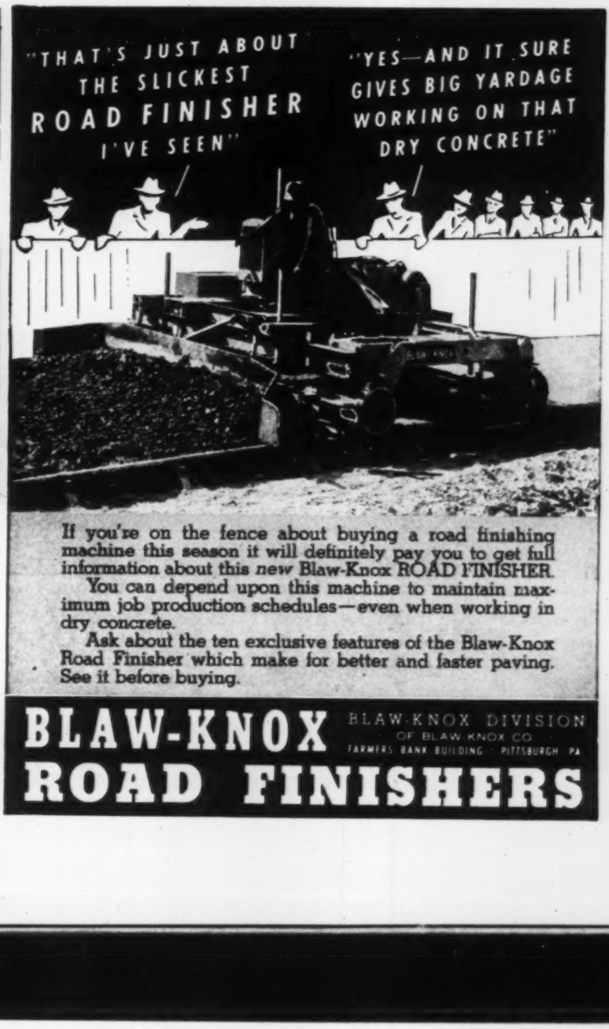

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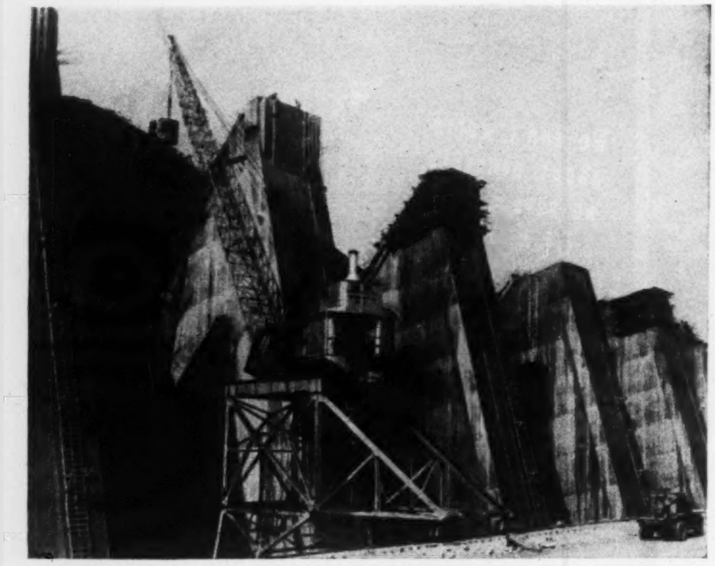

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ABSTRACTS AND NOTES

Snow-Survey Forecast For Water Supply

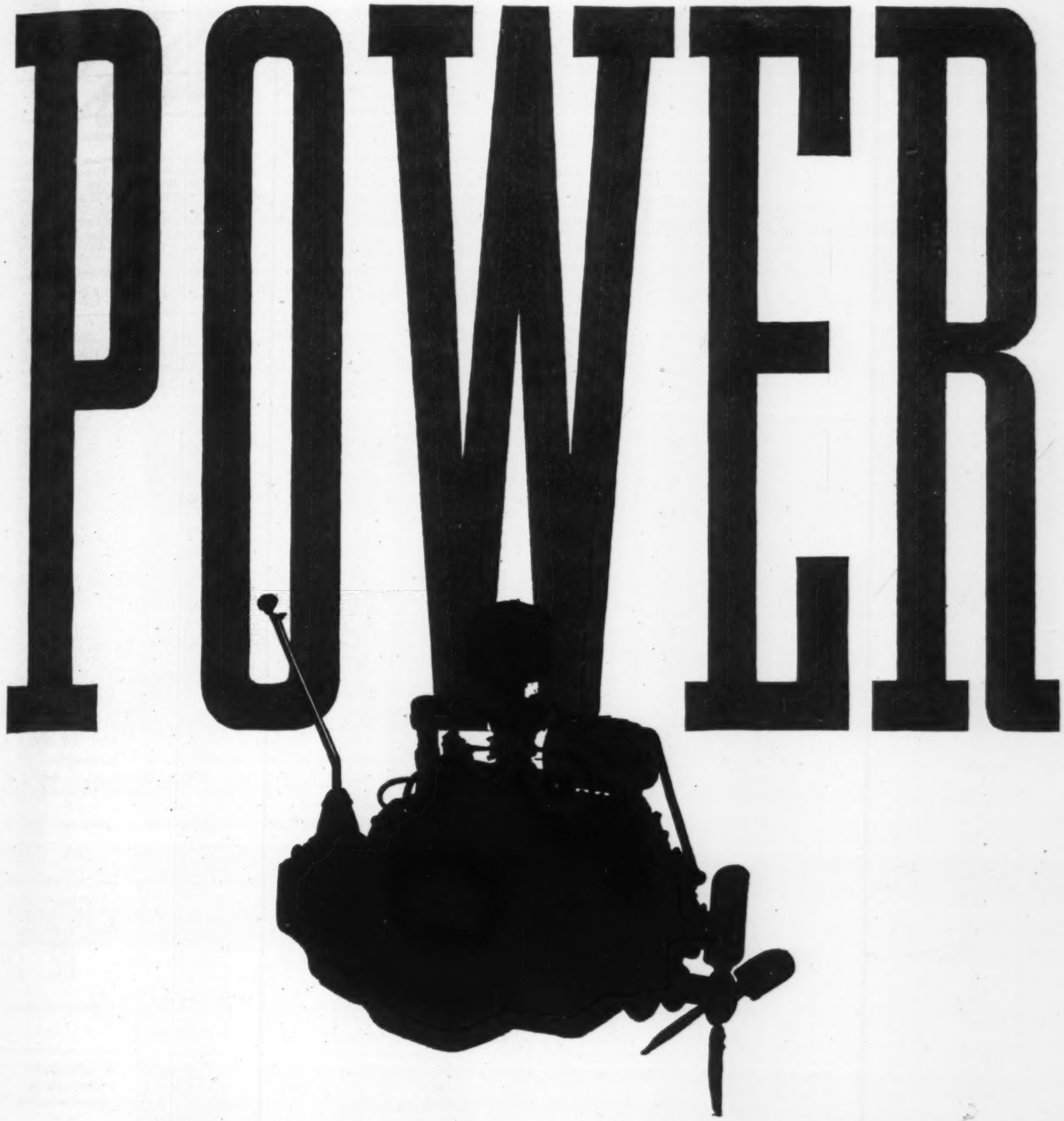
From the April snow survey and forecast of streamflow on the eastern slope of the Central Sierras, as conducted by the Nevada Cooperative Snow Surveys, it appears that the percentage of normal runoff will be much higher than last year. The high-level snow courses showed a range of 85 to 121 per cent of normal water content. The fall precipitation in September and October was relatively good, but too early for much lasting effect on winter soil moisture conditions. It was very low in November and December, but the deficiency was largely made up in January, February and early March. However, March temperature was above normal and much of the precipitation in January and March was in the form of rain below El. 7,000, so that early melting occurred and snow courses at low altitudes were much below normal on April 1. There was so much runoff in March that there was good storage by April.

In 1939, the precipitation and streamflow were low, but basins provided with storage fared well because of the carry-over from the unusually high-water year of 1938. The spring and early summer precipitation was only about half of normal, but the actual runoff was very close to that predicted by the snow survey forecast. The Nevada Cooperative Snow Surveys organization includes Nevada, California and federal government bureaus, and water power companies.

• • •

Apprentices for Contractors

Conference between the Associated Builders of Chicago and the local bricklayers' union is announced as resulting in a change of the regulations as to apprentices. Formerly, when a contractor took on an apprentice he had to agree to pay him for a three-year term, whether or not he had work for him all the time. Under the new arrangement, the union will furnish an apprentice on application and the contractor will be responsible only for his employment during such periods as work can be provided for him.



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MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

JUNE construction material prices show changes in cement, steel and lumber. Labor rate changes are also noted in four cities. Cement is off 57c. per bbl. in Los Angeles, 56c. in San Francisco, and 29c. in Minneapolis.

Reinforcing steel bars are 10c. per 100 lb. lower in Cincinnati, 30c. lower in Los Angeles, off 25c. in San Francisco, but up 25c. in Seattle. Expanded metal lath rose $1.00 per 100 sq. yd. in Baltimore. Sheet piling is up 5c. per 100 lb. in Seattle.

Short Leaf Southern Pine is 50c. to $1.00 higher in Atlanta and Baltimore. Native Pine is off $1.00 on 1-in. sizes in Denver, but up $1.00 on 2-in. sizes. Douglas Fir is up $1.00 in Baltimore.

Common brick is off 50c. per M in New York. Paving asphalt is 61c. per ton lower in Seattle.

Bricklayers' new rate in New York, $2.00 per hr., is an increase of 10c.; carpenters are expected to receive $1.85 per hr. beginning June 1; and structural ironworkers, $2.00 beginning July 1. Carpenters' rate in Denver is off 7c. to $1.43 per hr. Cincinnati structural ironworkers' current rate is $1.55, and hoisting engineers are receiving $1.37½ to $1.50 per hr.

Common labor rate in Cincinnati is 75c. per hr., whereas it formerly ranged from 60 to 75c. San Francisco common labor rate is 81¼c. per hr. for both building and heavy construction.

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included			SAND AND GRAVEL Per ton, carload lots			CRUSHED STONE Per ton, carload lots		CRUSHED SLAG Per ton, carload lots, f.o.b. plant		CONCRETE Ready Mixed 1:2:4, 50 c.y. or more, delivered
	Cloth Bags*a*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.90	$2.65	$2.61	$1.75	$1.85	$1.95	$1.65	$1.75	$1.55	$1.65	$7.90
Baltimore	2.31	2.06	1.86	1.70‡	1.70‡	1.20‡	1.75‡	1.75‡	1.75‡	1.75‡	6.50
Birmingham	2.50	2.25	2.05	1.80	1.80	1.50	1.00	1.00	.90	1.15	5.80
Boston	2.75*b*	2.50*b*	2.30	1.10‡	1.10‡	.80‡	1.10‡	1.10‡	....	....	6.75*m*
Chicago	2.60	2.35	2.20	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	1.25‡	1.25‡	....
Cincinnati	2.58	2.33	2.08	1.20	1.20	1.10	1.80	1.80	....	....	6.60
Cleveland	2.00	1.75	....	1.45*i*	1.45*i*	1.45*i*	1.70*i*	1.70*i*	1.70*i*	1.70*i*	6.55*i*
Dallas	2.30	2.05	1.85	2.00*p*	2.00*p*	1.50*p*	1.69*p*	1.84*p*	....	....	6.20
Denver	3.00	2.75	....	1.20	1.40	.90	....	....	....	....	7.25
Detroit	2.23	1.98	1.78	1.30	1.40	.80	1.30	1.45	1.02‡	1.14‡	6.50
Kansas City	2.56	2.31	2.16	1.85	2.30	1.00	1.91	1.91	....	....	7.90*n*
Los Angeles	2.25*b*	2.05*b*	....	1.00	1.00	1.00	1.00*f*	1.00*f*	....	....	5.85
Minneapolis	2.71	2.46	....	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	7.35*j*
Montreal	....	1.75*r*	1.60*r*	....	....	1.25‡	.85‡*c*	1.00‡*c*	....	....	6.45*l*
New Orleans	2.41	2.16	1.96	1.50	1.50	1.25	....	....	....	....	7.25
New York	2.60‡	2.35‡	....	1.40*de*	1.40*de*	.90*de*	1.65*de*	1.75*de*	....	....	7.00
Philadelphia	2.32	2.07	1.87	1.55‡	1.65‡	1.25‡	....	....	1.00	1.00	7.95*k*
Pittsburgh	2.44	2.19	1.99	1.40‡	1.40‡	1.70‡	2.25‡	2.25‡	1.50	1.50	7.50
St. Louis	2.55	2.30	....	1.50‡	1.50‡	1.25/1.50‡	.85*h*	.85*h*	.75*g*	.75*g*	7.50
San Francisco	2.16	1.96	1.66	1.36	1.36	1.36	1.46	1.46	....	....	6.95
Seattle	2.95*o*	2.70*o*	....	1.00*o*	1.00*o*	1.00*o*	2.00*o*	2.00*o*	....	....	7.25

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Plus municipal tax. *d* Per cu. yd. *e* Barge lots alongside docks *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days. *r* 10c. per bbl. off, cash 20 days.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice. Subject discount 10c. per bbl. 20 days in Montreal.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind	$1.70	$1.65	Ironton, Ohio	$1.60	$1.55	Richard City, Tenn	$1.80	$1.75
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.70	1.65	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.70	1.65	Norfolk, Va	1.65	1.60	Universal, Pa	1.65	1.60
Hudson, N. Y	1.75	1.70	Northampton, Pa	1.55	1.50	Waco, Tex. (5c. Tax inTex.)	1.75	1.70
Independence, Kans	1.70	1.65	North Birmingham, Ala	1.70	1.65	Montreal	1.55	1.55

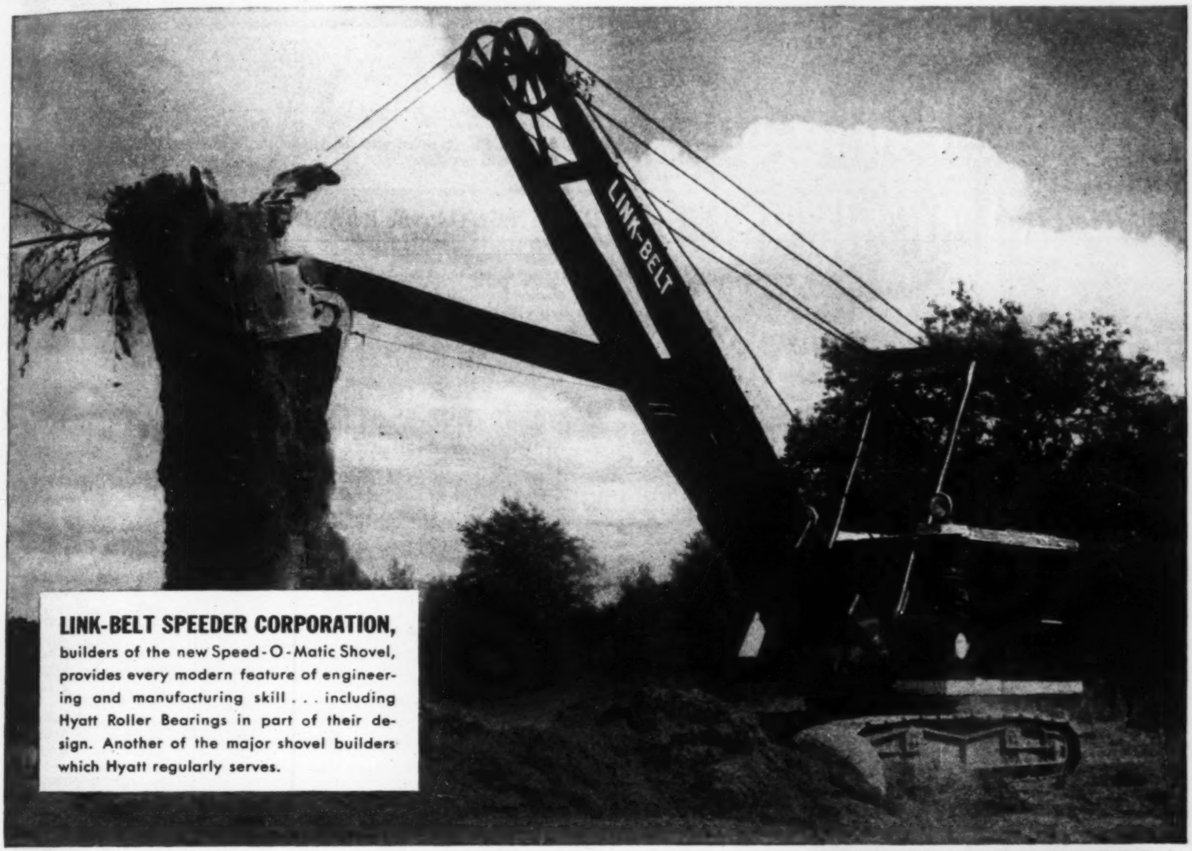
PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS			PAVING ASPHALT Per ton, less than 80 penetration		ASPHALT BINDERS — FLUXES Per gal. 80–300 penetration		CUTBACK ASPHALT Per ton		ROAD OILS Per gal.	ASPHALT EMULSION (Quick-breaking) Per gal.	
	Granite per M. lots of 50,000 4x4x8 in.	Brick per M. 3x4x8½ in. carload lots	Wood per sq. yd. 3½ in. 16-lb. treat	Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$73.00	$39.35	$2.25	$16.60*e*	$22.83*e*	$0.0645*e*	$0.1165*e*	$0.0684*he*	$0.1207*h*	$0.0634*e*	$0.0644	$0.0684
Baltimore	145.00‡	44.00‡	2.75	14.00	20.00	.06	.09	.065*h*	.115*h*	......	......	.....
Birmingham	......	28.50*j*‡	......	19.20	25.20	.0797	.1097	.0834*h*	.1334*h*	......	......	.....
Boston	90.00	47.00	3.25	14.00	20.00	.06	.09	.065*h*	.115*h*	......	.09‡	.12‡
Chicago	140.00	50.00	1.80*d*	14.00	18.00	13.00*g*	17.00*g*	.06*h*	.10*h*	.035	.08	.12
Cincinnati	112.00	37.50	......	14.31	18.31	.10	......	18.00	......	.0525	.....	.08
Cleveland	110.00	37.50	2.80	14.50	19.50	.065	.075	.07*h*	.085*h*	.0375	.08	.09
Dallas	......	30.00	......	13.25	20.30	.06	.103	15.00	24.80	.055	.05/.07	.07/.09
Denver	......	27.50	......	......	......	......	......	......	......	......	......	.....
Detroit	......	35.00	......	13.15*f*	18.45*f*	.061	.0984	13.15	17.20	.0475	.061	.0923
Kansas City	......	44.00	......	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	......	50.00	......	6.50*b*	15.00	6.50*bg*	15.00*bg*	5.50*b*	......	.0192	.0525	.1125
Minneapolis	......	......	1.90*d*	19.20	24.20	.10	.12	19.30	28.30	.056	......	.....
Montreal	75.00	......	3.62	14.60	21.25	.105	.1375	.101*h*	.121*h*	.07	.135	.188
New Orleans	......	......	......	14.00*a*	19.00*a*	.055	.085	.06*h*	.09*h*	......	.078	.....
New York	......	......	2.75	15.00	21.00	.06	.09	.065*h*	.115*h*	......	.07	.11
Philadelphia	120.00	42.50	2.84	14.00	19.00	.055	.08	.06*h*	.09*h*	.05	.06	.09
Pittsburgh	135.00	38.75	......	......	......	......	......	......	......	......	......	.....
St. Louis	110.00/121.00	37.00	......	14.00	19.00	14.00*g*	19.00*g*	.06*h*	.095*h*	.04	.09	.125
San Francisco	......	70.00	......	6.50	15.00	6.50*g*	15.00*g*	7.00	17.50	.025	.0525	.1125
Seattle	......	60.00*c*	......	14.70	22.90	......	23.50*g*	9.50/10.50	23.00/24.00	7.75*j*	.0575*i*	.1308*i*

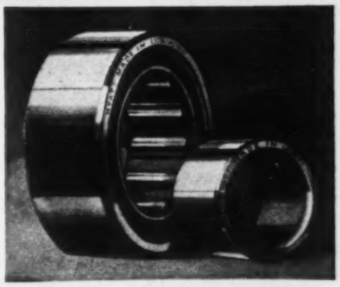
‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½x4x8½ in. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3x3⅝x8½ in.

(Continued on page 88)

Always MAKING THE GRADE



LINK-BELT SPEEDER CORPORATION, builders of the new Speed-O-Matic Shovel, provides every modern feature of engineering and manufacturing skill . . . including Hyatt Roller Bearings in part of their design. Another of the major shovel builders which Hyatt regularly serves.



WITH HYATTS ON THE JOB, mechanical equipment moves forward relentlessly . . . drives ahead . . . makes the grade. Depending on Hyatts to take the load, to conserve power, to keep them rolling, modern machines are forever free from bearing wear and care. Look to Hyatts to serve *you* best! Hyatt Bearings Division, General Motors Sales Corporation, Harrison, New Jersey; Chicago, Pittsburgh, Detroit and San Francisco.

HYATT

ROLLER BEARINGS

QUIET

(Continued from page 86)

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¾-in. billet *b*	RIVETS ⅞-in. structural	WIRE NAILS Base *d*	SHEET PILING Base	STEEL RAILS Per Gross Ton Standard	Light	Re-rolled	TRACK SUPPLIES Angle Bars	Std. Spikes *c*	Tie Plates *c*	Track Bolts
Birmingham	$2.10	$1.90	$3.40	$2.55	....	$40.00	$40.00	$39.00	$2.70	$3.00	$2.15	$4.15
Chicago	2.10	1.90	3.40	2.55	$2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Pittsburgh	2.10	1.90	3.40	2.55	2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Buffalo	2.10	1.90	....	....	2.40	....	....	....	....	....	2.15	....
Cleveland	2.10	1.90	3.40	2.55	....	....	....	....	....	....	....	....
Youngstown	....	1.90	....	....	....	....	....	....	....	3.00	....	....
Detroit	....	2.00‡	....	....	....	....	....	....	....	....	....	....
Gulf ports	2.45*a*	2.25*a*	....	....	2.85*a*	....	....	....	....	....	....	....
Pacific ports	2.75*a*	2.30*a*	....	....	2.95*a*	....	....	....	....	3.00	2.25	....

‡ Delivered. *a* F.o.b. cars dock. *b* Rail steel same as billet prices. *c* Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. *d* Add switching charge $18 per c.l.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS* Per 100 lb., ¾ in., base price 15 tons or over *b* New billet	Rail steel	Add Switch	$/cwt. for Del.	EXPANDED METAL LATH Per 100 sq.yd., carload lots Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING Per 100 s.f., carload lots 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in. No. 6 & 6 wires Per sq. yd.	SHEET PILING Per 100 lb. base price
Atlanta	$2.34	$2.39	$2.14	.02½	.10	$21.00	$23.00	$1.82	$1.35	$0.1719	$3.04
Baltimore	3.60	2.85	2.70	......	.10	22.00	24.00	1.70	1.27	.1611	2.75
Birmingham	2.10*a*	1.90	1.90	.02½	.10	19.50	21.50	1.80	1.34	.1701	....
Boston	3.85	2.61	2.46	$20 C.L.	.10	21.50	23.50	1.76	1.31	.1656	3.14
Chicago	2.10*a*	1.90	1.90	.03	.05	19.50	21.50	1.67	1.25	.1575	2.40
Cincinnati	3.68	2.41*c*	2.41*c*	......	.05	20.50	22.50	1.66	1.26	.1566	....
Cleveland	3.58*g*	1.90	1.90	.02½	.10	20.50	22.50	1.66	1.25	.1566	....
Dallas	4.75	3.25	3.25	......	......	25.00	27.00	1.93	1.42	.1827	....
Denver	4.35	3.95	3.80	......	......	23.50	25.50	1.97	1.45	.1863	....
Detroit	3.60‡	2.00	2.00	......	.10	22.50	24.50	1.68	1.26	.1584	2.66
Kansas City	4.03	2.51*c*	2.36*c*	.0	.05	18.50	20.50	1.78	1.33	.1683	2.86
Los Angeles	3.65*f*	2.25	2.10	.02½	.05	23.00	27.50	1.93	1.42	.1827	3.65
Minneapolis	3.80‡	2.48*c*	2.48*c*	.0	.10	21.50	24.50	1.80	1.34	.1701	2.73*d*
Montreal	3.90	2.70	2.60	......	......	26.50	29.00	2.99	2.08	.319	....
New Orleans	4.40	2.52	2.52	.05	.10	21.50	23.50	1.82	1.35	.1719	2.875
New York	3.75	2.39	2.39	......	.10	20.50	22.50	1.76	1.32	.1665	2.74
Philadelphia	3.55	2.66	2.56	......	......	19.50	21.50	1.71	1.28	.1611	2.72
Pittsburgh	2.10*a*	1.90	1.90	.02½	.10	21.50	24.50	1.59	1.20	.1503	2.40
St. Louis	3.47	2.39	2.39	.0	.05	24.00	28.00	1.69	1.27	.1602	2.70
San Francisco	3.35	2.275	2.125	.02½	.10	19.00	25.50	1.93	1.42	.1827	3.25
Seattle	2.75*e*	2.50*e*	......	......	......	25.50	27.50	1.93	1.42	.1827	2.95*e*

‡ Delivered. *a* Mill prices. *b* 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b dock. *f* Includes delivery in free delivery zone. *g* Less than 1 ton, add 30c.; 1 to 5 tons, add 10c. * High scrap steel prices cut former 15c. differences between new billet and rail steel in many mills.

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in.*a*	VITRIFIED SEWER PIPE Per foot, std. 8 in., s.s.	delivered std. 12 in., s.s.	ASTM 24 in.,	C13–35 36 in.,	CLAY DRAIN TILE Per 1,000 ft., carload lots, 6 in.	f.o.b. 8 in.	CONCRETE SEWER PIPE Per ft., delivered: ASTM 12 in.	C 14–35 24 in.	WROUGHT STEEL PIPE Full standard weight, *h* 1 to 3 in., Butt Weld Black %	Galv. %	3½ to 6 in., Lap Weld Black %	Galv. %
Atlanta	$49.40	$0.26*bc*	$0.468*bc*	$1.8525	$4.68*c*	$85.00	$128.00	$0.45	$1.625	62.2	54.2	59.7	51.2
Baltimore	52.80	.30	.55	2.30	6.80	110.00	150.00	.40	1.65	65.5	57.5	63.0	54.5
Birmingham	45.00	.26	.468	1.854	4.66	85.00	220.00	.40	1.60	62.2	54.2	59.7	51.2
Boston	55.00	.231	.4455	1.89	5.2275	180.00‡	280.00‡	.40	2.00	64.1	56.1	61.6	53.1
Chicago	53.80	.28	.54	2.25	6.25	100.00‡	150.00‡	.38	1.48	67.0	59.0	63.5	55.0
Cincinnati	52.70	.245	.4995	1.9335	5.6375	105.00	170.00	.60	1.70	65.9	57.9	63.4	54.9
Cleveland	54.24	.21	.405	1.665	4.8175	69.00	108.00	.35	1.50	67.8	59.8	65.3	56.8
Dallas	58.20	.265	.477	1.728	4.70	80.00	100.00	.46	1.57	59.9	51.9	57.3	48.3
Denver	60.60	.24†	.52†	2.16‡	......	130.00	240.00	......	......	58.4	50.4	55.7	47.2
Detroit	54.24	.245	.4725	1.935	4.408	66.45	105.00	.33	1.50	66.3	58.3	63.8	55.3
Kansas City	55.12	.30	.54	2.16	5.00	120.00	240.00	.45	1.60	62.9	54.9	60.0	51.5
Los Angeles	55.00	.282†	.508†	2.034†	5.085†	115.50	192.50	1.00	2.00	59.6	51.6	57.0	48.6
Minneapolis	57.20	.24†	.432†	1.728†	4.60†	......	......	.70	1.80	64.2	56.2	60.7	52.2
Montreal	60.00	.55	.90	3.68	5.95*e*	135.00‡	260.00‡	.48	1.92	......	......	......	......
New Orleans	51.38	.26	.48	1.69	......	150.00	220.00	.37	2.10	62.4	54.4	58.8	50.3
New York	52.20	.32	.63	2.52	6.45	......	......	.50	1.20	64.9	56.8	62.4	53.9
Philadelphia	50.90	......	......	......	......	......	......	.54	1.80	65.3	57.3	62.8	54.3
Pittsburgh	55.60	.245†	.4725†	1.845†	5.4325	97.80	154.20	.85*g*	2.00*g*	68.5*i*	60.5*i*	66.0*i*	57.5*i*
St. Louis	52.48	.24	.432	1.728	3.96	85.00	170.00	.75*j*	1.80*k*	65.1	57.1	62.0	53.5
San Francisco	55.00	.3275*d*	.5895*d*	2.358	5.895	107.25	178.75	.45	2.50	......	......	......	......
Seattle	55.35	.35	.63	2.52	6.30	72.00	175.00	.45*f*	1.40*f*	......	......	......	......

‡ Delivered. † F.o.b. *a* B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $49.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. *b* Double strength. *c* List to dealer. *d* List. *e* 30-inch. *f* Less 5% for cash. *g* Culvert pipe. *h* Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ½ in., 8½c.; ¾ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92. *i* Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less on butt, 1½ on lap. Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld—1 in. and 1¼ in. black 34, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld—2½ in. to 3½ in. black 31½, galv. 17½ in.; 4½ in. to 8 in. black, 32½ galv. 20. *j* Reinforced; spec. C 76-37. *k* Reinforced; spec. C 75-37.

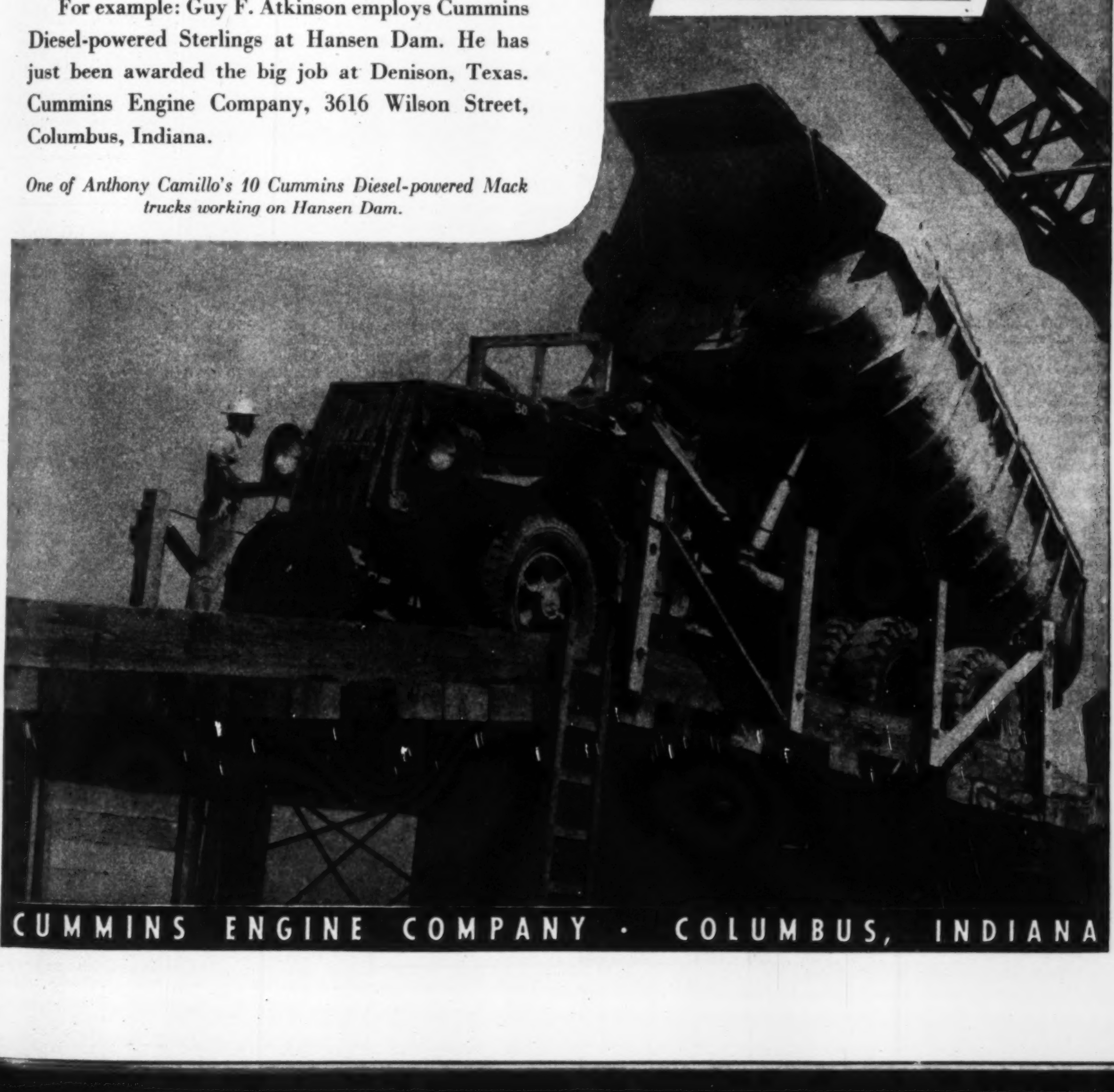
(Continued on page 90)

The Job You Want Done Is *Now* Being Done with CUMMINS Dependable DIESELS

for Example **If you're looking for lower dirt-moving costs, consider this:**

The Cummins Diesel's record on the big jobs like Hansen Dam, the Pennsylvania turnpike, the Mississippi flood control project . . . and many other nationally known jobs . . . have established, not only the engine's fuel economy and low maintenance, but its day and night dependability in all types of dirt-moving equipment — shovels, draglines and dump trucks. Check the low bidder on the big jobs and you'll find he's a Cummins Diesel owner.

For example: Guy F. Atkinson employs Cummins Diesel-powered Sterlings at Hansen Dam. He has just been awarded the big job at Denison, Texas. Cummins Engine Company, 3616 Wilson Street, Columbus, Indiana.



One of Anthony Camillo's 10 Cummins Diesel-powered Mack trucks working on Hansen Dam.

CUMMINS ENGINE COMPANY · COLUMBUS, INDIANA

(Continued from page 88)

LUMBER, TIMBER, PLYWOOD—PER M FT. B.M., CARLOAD LOTS F.O.B.

All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face)
All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR									LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD Rail freight increment (See note for base price)	
	1x6, S4S	1x8, S4S	2x4, S4S	2x6, S4S	2x8, S4S	2x10, S4S	3x12, Rgh	6x12, Rgh	12x12, Rgh	2x12, Rgh	12x12, Rgh	5/8"	3/4"
Atlanta	**$19.00**	**$19.00**	**$18.00**	**$19.00**	**$19.50**	**$20.00**	**$26.00**	......	......	$37.50	$50.50	$17.75	$21.60
Baltimore	**31.00**	**32.50**	**37.50**	**36.50**	**37.00**	**38.00**	**46.00**	......	......	68.00	68.00	17.35g	21.15g
	33.00	*33.00*	*35.00*	*34.00*	*35.00*	*35.00*	*46.00*	*$46.00*	*$42.00*	......	......	......	......
Birmingham	**22.50**	**23.50**	**22.00**	**21.00**	**22.00**	**23.00**	**37.00**	**36.00**	**36.00**	......	......	16.25	19.85
[1]	25.50	25.50	29.00	27.00	29.00	40.00	60.00	......	......	54.00	57.00	......	......
Boston	30.00[2]	30.00[2]	32.00[3]	32.00	53.00[1]	60.00[1]	77.00[1]	......	......	77.00	77.00	17.35g	21.15g
	28.00	*28.00*	*32.00*	*32.00*	*38.00*	*38.00*	*45.00*	*45.00*	*45.00*	......	......	......	......
Chicago	**31.00**	**31.00**	**30.00**	**30.00**	**30.00**	**31.00**	**50.00**	......	......	80.00	90.00	13.15	16.05
	36.00	*36.00*	*37.00*	*37.00*	*38.00*	*39.00*	*43.00*	*42.00*	*42.00*	......	......	......	......
Cincinnati	**31.50**	**33.00**	**30.50**	**31.00**	**32.00**	**35.00**	**44.50**	......	......	53.00	56.00	16.25	19.85
	......	......	......	......	......	......	*46.00*	*46.00*	*46.00*	......	......	......	......
Cleveland	**32.00**	**32.50**	**33.00**	**33.00**	**36.00**	**38.00**	**45.00**	46.00	46.00	80.00	80.00	16.70	20.40
Dallas e	**28.50**	**32.50**	**31.50**	**29.00**	**30.50**	**32.50**	**52.50**	**52.50**	**52.50**	63.50	71.00	13.90	16.95
Denver ‡	45.00[4]	44.00[4]	43.00[4]	41.00[4]	41.00[4]	46.00[4]	48.00[4]	60.00[4]	71.50[4]	......	......	9.90	12.05
Detroit	**35.00**	**35.00**	**35.00**	**35.00**	**38.50**	**42.00**	**46.00**	......	......	43.50	58.00	16.25	19.85
	......	......	......	......	......	*46.00*	*47.00*	*54.00*	*54.00*	......	......	......	......
Kansas City	**28.00**	**29.00**	**29.00**	**28.00**	**29.00**	**30.00**	**35.00**	......	......	55.00	60.00	12.25	14.95
	29.00	*29.00*	*30.00*	*28.50*	*29.00*	*30.00*	*35.00*	*39.00*	*39.00*	......	......	......	......
Los Angeles a	*36.00*	*35.00*	*36.00*	*33.00*	*33.00*	*33.00*	*38.00*	*46.00*	*39.00*	......	......	9.35gh	11.35gh
Minneapolis ‡b	47.00[6]	47.00[6]	......	......	......	......	......	......	......	......	......	12.05	14.70
‡	*38.00*	*38.00*	*39.00*	*39.00*	*39.00*	*39.00*	*59.00*	*59.00*	*59.00*	......	......	......	......
Montreal [7]	*34.00*	*36.00*	*32.00*	*34.00*	*36.00*	42.00	45.00	......	......	**155.00**	**165.00**	......	......
	52.00	*54.00*	*52.75*	*55.75*	*57.75*	*60.75*	*52.00*	*52.00*	*52.00*	......	......	......	......
New Orleans	**24.00**	**25.00**	**25.00**	**24.00**	**24.00**	**25.00**	**46.00**	......	......	62.00	69.00	13.90	16.93
	29.00	*29.00*	*32.00*	*33.00*	*35.00*	*34.00*	*36.00*	......	......	......	......	......	......
New York ‡	**38.00**	**39.00**	**37.00**	**38.00**	**38.00**	**39.00**	**42.00**	......	......	80.00f	82.50f	17.35g	21.15g
‡	......	......	*45.00*	*45.00*	*45.00*	*45.00*	*45.00*	*47.50*	*47.50*	......	......	......	......
Philadelphia	**24.00**	**24.50**	**25.50**	**25.50**	**27.50**	**27.50**	**29.00**	......	......	50.00	57.50	17.35g	21.15g
	35.00	*36.50*	*39.00*	*38.25*	*39.00*	*39.00*	*44.00*	*32.00*	*32.00*	......	......	......	......
Pittsburgh	**38.10**	**39.90**	**47.05**	**42.00**	**45.65**	**46.90**	**59.70**	......	......	......	......	17.00	20.70
	51.90	*49.60*	*49.60*	*49.00*	*48.90*	*49.25*	*66.55*	*66.55*	*66.55*	......	......	......	......
St. Louis ‡c	**32.50**	**32.50**	**32.00**	**31.00**	**32.00**	**33.00**	**47.00**	*51.00*	*51.00*	73.00	72.00	13.90	16.95
San Francisco d	*22.50*	*23.00*	*23.00*	*22.50*	*22.00*	*22.50*	*23.50*	*23.50*	*23.50*	......	......	7.30g	8.90g
Seattle	*21.00*	*21.00*	*21.00*	*21.00*	*21.00*	*21.00*	*26.00*	*26.00*	*26.00*	......	......	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [6] Western Pine, No. 3 Common. [7] Spruce. [8] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off. *f* Up to 18 ft.

Note: Special concrete form grade Fir Plywood, 4′ by 8′ panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on 5/8", $77.00; on 3/4", $84.80; price includes oiling and sealing charges. For other centers add rail freight increment from table or proper size. For resin dipped treatment, add $10.50 per M. *g* Lower ate by water shipment. *h* 50,000 lb. minimum.

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS Discounts from jobbers list, Aug. 15, 1938 Single or Double Thickness		EXPLOSIVES Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*
	A quality	B quality	
Atlanta	75%	75%	$0.15
Baltimore	83%	82%	.15
Birmingham	89%d	85%d	.105
Boston	82%	82%	.15
Chicago	79%	79%	.15
Cincinnati	79%	79%	.15
Cleveland	79-10-10%	79-10-10%	.19
Dallas	78%	78%	.165
Denver	76-10%	76-10%	.15e
Detroit	79-10%	79-10%	.15
Kansas City	77-10%	77-10%	.155
Los Angeles	86%d	88%d	.1575
Minneapolis	76%	76%	.155
Montreal	60-5%ab		.17†
New Orleans	70%	75%	.16
New York	82%	83%	.20f
Philadelphia	82-10%d	83-10%d	.15
Pittsburgh	79%	79%	.1425
St. Louis	79-10%	79-10%	.155
San Francisco	78%d	83%d	.155
Seattle	85%d	88%d	.1575

Price of 60% Ammonia Gelatin is $0.015 per lb. higher than 40%

a Disc. from list Sept. 1939. *b* Also less 6% tax exemption. *d* Discount from jobbers' list Sept. 15, 1928.

* Urban prices influenced by service charges or local storage and del very regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla.	$0.105	$0.14	$0.16
W. of Miss., to Rocky Mtn. States, and Fla.	.11 -.12	.135 -.15	.155 -.17
Rocky Mtn. States	.11 -.1325	.13 -.145**	.15 -.165**
Pacific N. W. States	.1075-.115	.1375-.15	.1575-.17
Pacific S. W. States	.1050-.1175	.135 -.1475	.155 -.1625

** F.o.b. Louviers, Colo., or Butte, Mont.

PILES, TIES—F.O.B.

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf Barge	Short Leaf Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.18	$0.195
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.225	.24
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.23	.255
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.24	.265
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.28	.275
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.40	.415
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.42	.482

RAILWAY TIES

Prices f.o.b., per tie for carload lots:		6"x8"x8' Untr.	6"x8"x8' Tr.	7"x9"x8'6" Untr.	7"x9"x8'6" Tr.
Boston	**Oak**	$1.20	....	$1.65	....
	Pine	1.50	$2.25a	2.25	$3.20a
New York	S. L. Sap Pine	1.10/1.20	1.85	1.50	2.35
	Mixed Oak	1.45	1.95	1.90	2.45
Birmingham	**White Oak**	.85	1.50a	1.35	1.70a
	Southern Pine	.55b	1.10ab	.70	1.30a
Chicago	**Oak**	....	1.65a	....	2.25a
	Southern Pine	....	1.53a	....	2.13a
Los Angeles	Douglas Fir	.64	1.38a	.90	1.80a
Philadelphia	Red Oak	1.10	....	....	2.40a
St. Louis	White Oak	1.12	....	1.50	....
	Red Oak	1.12	1.60a	1.50	2.05a
	Sap Pine or Cypress	1.02	....	1.40	....
San Francisco	Douglas Fir	.90bef	....	....	1.95caf
Montreal	Birch or Maple	.65	1.05a	.75	1.35a

Tr.—Treated; Untr.—Untreated. *a* Creosoted. *b* 6"x8"x8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb.	$2.00-2.85
Chlorine cylinders, liquid, per lb. delivered	.0525
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton	20.50-35.00
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb.	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.10
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00
Sulphate of copper, in bbl., per 100-lb.	4.60

(Continued on page 92)

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(Continued from page 90)

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE — PARTITION — SCORED Per M. lots of 2,000 pieces or over,			STRUCTURAL CLAY TILE — LOAD BEARING — SCORED Per M. lots of 2,000 pieces or over,			BRICK Per M. in quantity.		LIME		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Per ton, Hydrated finishing	In paper Common hydrated	Carload lot Pulverized or lump
Atlanta	$90.00	$100.00	$185.00	$220.00	$230.00	$240.00	$12.50	$16.00	$26.50	$17.00	$17.00
Baltimore	74.00	80.00	165.00	190.00	240.00	290.00	13.00*k*	16.00*k*	18.50	14.50	2.50*m*
Birmingham	80.00	85.00	160.00	191.00	252.00	288.00	13.50	16.50	18.11	12.35	1.66*lo*
Boston	95.05*a*	101.40*a*	190.05*a*	215.35	279.20*a*	319.10*a*	17.00*i*	20.00*i*	20.00	13.00	17.00*l*
Chicago	68.10	72.60	135.90	185.70	234.90	268.10	11.00	12.00	16.40	14.40	12.20
Cincinnati	61.40	65.30	121.90	141.50	187.30	215.20	16.00	16.00	15.90	13.00	.....
Cleveland	56.50	60.00	112.50	135.00	182.50	209.50	16.00	16.00	15.00*j*	12.00*j*	2.75*jm*
Dallas	62.50	67.00	135.00	162.00	177.00	263.00	11.50*i*	13.50*i*	19.00	15.00	.95*n*
Denver	84.80	95.40	152.70	178.20	212.00	227.90	13.50	17.00	28.00*j*	17.00*j*	35.00*j*
Detroit	68.90	73.50	137.80	175.50	232.00	265.00*e*	15.70	17.00	13.50	11.75	12.75
Kansas City	64.50	66.50	86.00*c*	125.50	159.75	186.25	14.00	24.00	19.10	12.80	10.70
Los Angeles	73.50†*r*	89.50†*r*	128.00*c*†*r*	210.00†*r*	368.00†*r*	460.00†*r*	13.00	15.00	16.50	.....	17.50
Minneapolis	66.70	71.20	122.50	141.30	149.30	209.40	13.10	15.10*g*	21.00	16.00	19.00
Montreal	72.20*a*	77.50*a*	142.50*a*	76.00*at*	165.80*a*	248.70	20.75	28.00	23.50	17.00	11.00
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	.....	18.30	12.08	14.10
New York	87.00	93.00	128.00*c*	193.30*h*	238.80*h*	295.60*h*	13.00	.....	19.00	14.00	17.50
Philadelphia	80.50	85.90	161.10	193.30	238.80	295.60	15.00*s*	18.00*s*	15.50*q*	9.55*q*	12.05*q*
Pittsburgh	58.40	62.40	116.85	124.00	153.00	193.75	17.00	25.00	17.90	15.40	2.55*m*
St. Louis	62.00	88.00	120.00	180.00	234.00	280.00	16.00	17.00	22.00	16.00	2.30*lm*
San Francisco	84.00	94.50	225.00	......	......	......	14.00	17.00	.55*o*	.40*o*	2.05*m*
Seattle	100.00	110.00	220.00	......	......	......	17.50*f*	17.50*f*	20.00*s*	20.00*s*	20.00*s*

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6 x 12 x 12 in. *d* Not load bearing. *e* 48 lb. tile. *f* Less $1.00, ½ cash 15 days, balance 30 days. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* 50c per M. off for cash. *j* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb. *n* Per sack 100 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *q* 25-ton cars. *r* 5% discount 10 days. *s* 2% off cash. *t* 5½ x 8 x 12.

PAINT, ROOFING—F.O.B. CARLOAD LOTS

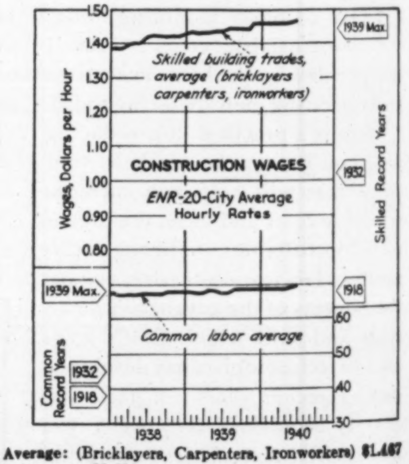
	RED LEAD Per 100 lb. in. 600-lb. (Approx.) bbl.	WHITE LEAD	READY-MIXED PAINT Per gal., drums			ROOFING SUPPLIES Carload lots f.o.b. factory				
	Dry *a*	Per 100 lb. in oil	Graphite *b*	Aluminum *c*	Ferric Oxide *d*	Rolls, slate surfaced, 85–90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl. per ton
Atlanta	$8.75	$13.125	$1.30	$2.25	$1.20	$1.90	$1.61	$1.61	$0.27	$29.00
Baltimore	8.50	12.75	1.70	2.45	1.95	2.20	2.75	2.75	.45	27.50
Birmingham	8.75	13.125	2.68	2.75	1.85	1.92	1.77	1.77	.45	27.00
Boston	8.50	12.75	1.75‡	2.30‡	1.75‡	1.75‡	1.85*h*‡	1.85*h*‡	.50‡	20.00‡
Chicago	8.50	12.75	1.96	2.63	1.68	1.48*hf*	1.55*hf*	1.55*hf*	.26*f*	21.00*f*
Cincinnati	8.50	12.75	1.65	2.85	1.55	2.40	2.39*h*	2.39*h*	.36	21.00
Cleveland	8.50	12.75	1.90	2.60	1.60	1.75	1.50*h*	1.50*h*	.35	21.00
Dallas	8.50	13.50	1.88	2.11	....	2.75*h*	2.60*h*	2.70*h*	.275	34.00
Denver	9.00	13.25	1.65	2.40	.17*l*	2.45	4.00	3.00	.35	18.00
Detroit	8.50	12.75	2.00	3.00	1.75	2.40	2.75	2.75	.35	27.50
Kansas City	8.50	12.875	2.15*g*	2.40*g*	1.67*g*	1.93	2.09	2.09	.25	25.00
Los Angeles	8.75	13.25	1.60	2.25	2.30	2.10	1.50	....	.45	...
Minneapolis	8.50	12.875	....	....	....	1.75*i*	1.50*hi*	1.50*hi*	.29	21.00
Montreal	9.25	9.00	2.25	2.80	2.35	2.53	1.68	1.78	.70	1.68*k*
New York	8.50	12.75	1.88	2.55	1.60	1.75	1.50*h*	1.50*h*	.23	24.00
Philadelphia	8.50	12.75	....	....	....	1.92*e*	1.99*he*	1.99*he*	.41*e*	21.00
Pittsburgh	8.50	12.75	1.05	1.95	.80	1.95	1.94*h*	1.94*h*	.34	26.00
St. Louis	8.50	12.75	1.90/2.00	2.60/2.85	1.60/2.00	1.47	1.50	1.50	.22	21.00
San Francisco	8.75	13.00	1.80	2.75	1.10/2.00	1.65	2.26	2.26	.28	17.00
Seattle	8.75	13.25	1.80	2.60	....	1.81	1.30/2.00	1.75	.35	28.00*j*

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3-49A. *c* ASTM Spec. D266-31. *d* 80% minimum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal can *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* per 100 lb *l* per lb.

SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$1.25	$1.00	$1.375	$1.00/1.25	$1.375	$0.40/.50	$0.40/.50
Baltimore	1.50	1.25	1.65	1.50	1.25	.5625	.5625
Birmingham	1.50	1.125	1.25	1.125	1.00	.30/.40*a*	.30/.40*a*
Boston	1.50	1.375	1.50	1.625	1.625	.60/.85	.60/.85
Chicago	1.70	1.625	1.70	1.70	1.70	1.025	1.025
Cincinnati	1.625	1.45	1.55	1.375/1.525	1.625	.75	.75
Cleveland	1.625	1.375	1.50	1.50/1.75	1.50	.90	.90
Dallas	1.50	1.00	1.25	1.00	1.50	.40/.50	.40/.50
Denver	1.65*b*	1.43*b*	1.43*b*	1.43	1.50*b*	.718*b*	.718*b*
Detroit	1.50	1.25	1.50	1.50	1.55	.60/.75	.60/.75
Kansas City	1.625	1.375	1.50	1.50	1.575	.85	.50
Los Angeles	1.25	1.10	1.375	1.375	1.50	.625	.625
Minneapolis	1.375	1.25*d*	1.50	1.40	1.50*e*	.85	.85
New Orleans	1.50	1.20	1.50	1.50	1.40	.40	.40
New York	2.00*b*	1.85*b*	1.925*g*	2.00*b*	2.00*c*	1.031	.875/.95
Philadelphia	1.65*b*	1.40	1.65	1.50	1.75	.70	.70
Pittsburgh	1.75	1.50	1.50	1.25	1.75	.80	.70
St. Louis	1.50	1.50	1.75	1.75/2.00	1.75	.45/.875	.875
San Francisco	1.75*c*	1.25*f*	1.50	1.50	1.60*c*	.813	.813
Seattle	1.60*c*	1.25	1.50*c*	1.50*c*	1.60*c*	.90*c*	.90*c*
Montreal	.80	.70	.75	.65	.80	.45	.40

a PWA. *b* 7 hr. day. *c* 6 hr. day. *d* 35 hr. wk. *e* 30 hr. wk. *f* Working under "stop-gap" agreement. *g* Increases to $2.00 July 1.



ENR Skilled Average: (Bricklayers, Carpenters, Ironworkers) $1.467
ENR Common Average: $0.690